SCIENCE DIGEST

JANUARY 1969 · 50 CENTS ICD

"VIKING" CRYPTOGRAMS–

Who carved them? Battles rage over what they say. To see if you can translate them turn to page 7

Engineering shambles: THE SST

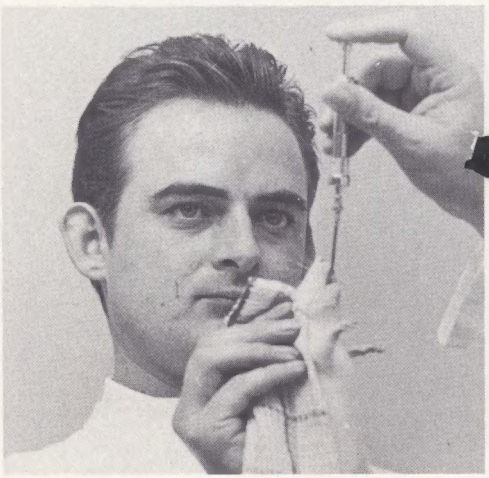
Isaac Asimov: Biological clocks and how they work

Quacks, the would-be MDs who can harm you

HICCUPS: our useless reflex, and what to do about it

SPECIAL: Micro-Mini circuits, the ultimate in mini-electronics

George V. Kelvin



BIPS

YIPPEEE!

HUMANS may swing from chandeliers when they're boozed up. But it's doubtful, judging from experiments to determine effects of alcohol on the nervous system of white mice. This fellow was a one-hand-swinger when sober. After a healthy slug, he lost his grip.

MAIL ORDER SHOPPING MART UNUSUAL VALUES

A selection of products available by mail for readers of Science Digest.
All merchandise sold on a money-back guarantee. Order Direct by Stock No. Send check or M.O.

See Music In Dazzling Action

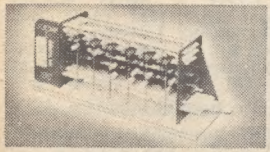
MUSIC VISION Dramatic Breakthrough in Audio-Visual Enjoyment

Actually *see* favorite musical selections translated into fantastic patterns of beautiful color—*each individual note* creating its own unique, twisting, radiating shape . . . each shape dancing and prancing, whirling and swirling in *perfect time with the music*. Easily attached to stereo, radio, tape recorder. **Send 25¢ in coin for 16-page booklet #9096AD**

Stock No. 85,151AD—WALNUT CABINET MODEL $99.50 FOB
Stock No. 71,030AD—8" SET ..... 45.00 Ppd.
Stock No. 71,009AD—8" DO-IT-YOURSELF KIT .. 22.50 Ppd.

WFF'N PROOF - GAMES OF LOGIC

Practice abstract thinking and math logic. Developed by Yale prof. If you think learning should be fun, try WFF'N PROOF brain-to-brain combat! 21 games of progressive difficulty. Starts with simple games mastered by 6-year-olds, ends with subtle logic to challenge professional logicians. 8½" x 5¾" case contains logic cubes, playing mats, timer & 224-p. book.
Stock No. 60,525AD ..$6.00 Ppd.



MODEL DIGITAL COMPUTER

Solve problems, teach logic, play games with miniature version of giant electronic brains! Adds, subtracts, multiplies, shifts, complements, carries, memorizes. Colored plastic parts easily assembled. 12"x 3½"x4¾". Incld. step-by-step assembly diagrams, 32-p. instruction book covering operation, computer language (binary system) programming, problems & 15 experiments.
Stock No. 70,683AD ..$5.98 Ppd.

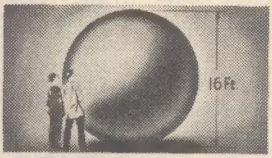
BIG, NEW DIGICOMP II!
Stock No. 70,946AD...$16.00 Ppd.

WOODEN SOLID PUZZLES

Here's a fascinating assortment of 12 different puzzles to provide hours of pleasure and stimulate ability to think and reason. Animals and geometric forms. Take them apart and reassemble them. Lots of fun for the whole family—young and old. Will test skill, patience and ability to solve problems. Order yours now.
Stock No. 70,205AD ...$4.00 Ppd.

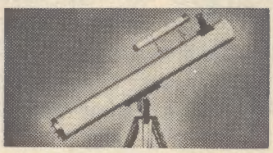
NEW ULTRASONIC CLEANER

Now a top-quality unit for only $39.95. Cleans dirt, grime completely, quickly, safely. Small delicate parts, precision electronic items, lab instruments, jewelry, coins, even dentures sparkle like new. 1/3rd pint capacity. Operates on regular house current. Precision American-made. Full 1 year guarantee. Solid state generator with automatic turn-off to prevent overheating. Power control regulating knob. Grounded to prevent shock. No radio interference. 6"x4"x4" stainless steel and metal cabinet. Incl. 3" diam. x 1½" deep (½ pint) crystal beaker, 4 cleaning solution powders, compl. instr.
Stock No. 71,003AD ..$39.95 Ppd.
1½ GAL. INDUS. CLEANER
No. 85,128AD. ...$249.95 F.O.B.



GIANT WEATHER BALLOONS

"Balls of fun" for kids, traffic stoppers for stores, terrific for amateur meteorologists. Create a neighborhood sensation. Great backyard fun. Exciting beach attraction. Amateur meteorologists use to measure cloud heights, wind speed, and temp. Made of heavy duty neoprene. Inflate with vacuum cleaner or auto air hose; or locally available helium for high rise.
Stock No. 60,568AD 8' $2.00 Ppd.
Stock No. 60,632AD 16' $7.00 Ppd.



3" ASTRONOMICAL TELESCOPE

See stars, moon, phases of Venus, planets close up. 60 to 180 power—famous Mt. Palomar reflecting type. Aluminized & overcoated 3" diameter f/10 primary mirror, ventilated cell. Equipped with 60X eyepiece and mounted 3X finder scope, hardwood tripod. FREE: "STAR CHART"; 272-page "HANDBOOK OF HEAVENS"; HOW TO USE YOUR TELESCOPE" book.
Stock No. 85,050AD ..$29.95 Ppd.
4¼" REFLECTOR TELESCOPE
Stock No. 85,105AD..$84.50 FOB
6" REFLECTOR TELESCOPE
Stock No. 85,086AD .$199.50 FOB

NOW! WATER THAT CLIMBS UP HILL

Amaze your friends - loads of fun - perfect for Science Fair. Water actually flows up side of glass & siphons freely into other container. To stop flow - cut with scissors - watch it snap back. Secret's in special additive with long molecular structure - req. only ½ tsp. to glass. Friction reducing additive has all kinds of industrial, agricultural, experimental uses - a pinch even makes gold fish slide thru water faster. 3 oz. can enough for 84 pints of water.
Stock No. 41,086AD .\.$2.00 Ppd.

GIANT FREE CATALOG

148 Pages! More than 4,000 UNUSUAL BARGAINS!

Completely new. Huge selection of telescopes, microscopes, binoculars, magnets, magnifiers, lenses, prisms, Science Fair items, kits, parts. Thousands of components - accessories of all descriptions. Many hard-to-find surplus values. 100's of charts, illustrations, diagrams. A veritable treasure house of optical, science and math buys at terrific savings. Every item guaranteed—complete satisfaction or your money back. Write for Free Catalog "AD." Edmund Scientific Co., 300 Edscorp Bldg., Barrington, New Jersey 08007.

Name
Address
City
State Zip

ORDER BY STOCK NUMBER • SEND CHECK OR MONEY ORDER • MONEY-BACK GUARANTEE

EDMUND SCIENTIFIC CO. 300 EDSCORP BUILDING BARRINGTON, NEW JERSEY 08007

ONE OF THE REWARDS of this business is that, every now and then, an unsolicited manuscript flies in over the transom from someone with a great idea that needs only a bit of a twist to make a fascinating feature.

A couple of months ago Mark Roberts, an Oklahoman with a passion for archaeology—and a dedicated cryptographer to boot—sent us an interesting account of the dis-

THIS MONTH

covery of two runestones thought by many experts to be genuine monuments left by genuine Vikings before Columbus ever set foot in America. These artifacts are located in—of all places—Oklahoma, which happens to be a state in the dead center of the United States. What were Vikings doing that far from the sea? Are the stones really genuine or, like other American runes, are they suspected frauds or practical jokes carved by Scandinavian Americans familiar with the runic alphabets?

Some of the answers are in the article on page 7. But there's a lot more than that. We thought our readers might enjoy taking a crack at deciphering these strange messages themselves. So we had a good archaeological researcher dig up the important runic alphabets and their English equivalents, plus a lot of information on how to proceed. It's all there. Have fun.—*RFD*

SCIENCE

RICHARD F. DEMPEWOLFF, Editor
DAVID COLEMAN, Managing Editor
BARBARA O'CONNELL, Assistant Editor
JERRY GREER FALES, Assistant Editor
GEORGE V. KELVIN, Art Director
JOHN M. MITCHELL, School Department

Contributing Editors

ISAAC ASIMOV, Ph.D., Biochemistry
JOSEPH D. WASSERSUG, M.D., Medicine
DANIEL COHEN, General Science
BRUCE FRISCH, General Science
JEANNE REINERT, General Science
MELVIN HERMAN, Psychiatry
STACY V. JONES, Inventions
FLORA SCHREIBER, Psychiatry
ARTHUR SNIDER, Medicine
M. and J. DAUGHERTY, Quiz

Editorial and general offices:
575 Lexington Ave., New York, N.Y. 10022

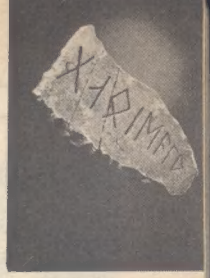
Subscription offices:
250 West 55th Street, New York, N.Y. 10019

Advertising offices:
GERARD PROVENCE, Advertising Director
575 Lexington Ave., New York, N.Y. 10022
Phone 212 MU 8-8500

Chicago: 520 N. Michigan Ave. 527-2400, J. Nielan, Manager. Detroit: General Motors Bldg., TRinity 5-8711, R. Nelson, Manager. Cleveland: Hanna Bldg., 1422 Euclid Ave., PRospect 1-0456, William Leavenworth, Manager. Los Angeles: 601 No. Vermont., 666-6263, M. Foss, Manager. San Francisco: 1101 Hearst Bldg., YUkon 2-0823.

SCIENCE DIGEST is published monthly by The Hearst Corporation, 959 Eighth Avenue, New York, N.Y., 10019. RICHARD E. BERLIN, *President;* GEORGE HEARST, *V-Pres.;* RICHARD E. DEEMS, *President of Magazines;* JOHN R. MILLER, *Executive V-Pres., Magazines;* WILLIAM S. CAMPBELL, *V-Pres., Magazines;* ALBERT A. RACHOI, *V-Pres. and Director of Circulation;* RAYMOND J. PETERSEN, *Senior V-Pres. of Magazines;* FRANK MASSI, *Executive V-Pres. and Treas.;* HARVEY L. LIPTON, *Sec.*

DIGEST®



The American runestone controversy has boiled since the turn of the century. Some experts claim the Scandinavian-style carvings are authentic, that they were carved in the United States 100 years before the arrival of Columbus; others swear the stones are frauds. But nobody is even sure what the stones say, and their translation is up for grabs. You can try your hand at solving the mystery on page 7.

Cover drawing by George V. Kelvin.

JANUARY • 1969 Vol. 65 No. 1

CONTENTS

SCIENCE NEWS
Bulletins at Press Time 4
Science Month 21
New for People 30
New for Industry 58

ARCHAEOLOGY
Roman Palace 32

AVIATION
Engineering Shambles: The SST 34

ELECTRONICS
SPECIAL: LSI: Micro-mini Circuits .. 43

ENGINEERING
Breakthrough in Ice Breaking 15

INVENTIONS
CAT Means Bad Luck to Pilots 69

MEDICINE
Quacks—The Would-be MDs Who Can Harm You 16
Lightning Victims—Back From the Dead 64

OCEANOGRAPHY
The Racing Tides 60

PALEONTOLOGY
New Home for Old Bones 41

PHYSIOLOGY
Hiccups: The Good-for-Nothing Reflex 70

SCIENCE MYSTERY
Riddle of the 'Viking' Cryptograms .. 7

TECHNOLOGY
Electron Scanning Microscope 26

DEPARTMENTS

This Month 2
Colleges in Action 75
Isaac Asimov Explains 78
Quiz 81
Books 84
Letters 91
Index 94

SUBSCRIPTION PRICES U.S.A. and Possessions, $5.00 for one year; $9.00 for two years; $13.00 for three years. Canada, add 50¢ for each year. All other countries, add $1.00 for each year. Special Teachers' and Students' rates available through SCIENCE DIGEST School Plan. 25¢ a copy, minimum order 10 copies per month. Write to: SCIENCE DIGEST School Dept., at address below. Subscription Service: Mail all subscription orders, changes of address, correspondence concerning subscriptions, and Postmaster notices of undeliverable copies to SCIENCE DIGEST, Box No. 654, New York, N. Y. 10019. Please enclose your latest address label for quickest service when writing about your subscription.—Second-class postage paid at New York, N. Y., and at additional mailing offices. Registered as second-class mail at the post office, Mexico, D. F., Mexico, June 20, 1950. Authorized as second-class mail by Post Office Department, Ottawa, and for payment of postage in cash. SCIENCE DIGEST is indexed in READER'S GUIDE TO PERIODICAL LITERATURE. Printed in the U.S.A. Contributions must be accompanied by a self-addressed and stamped envelope.

NEWS IN BRIEF

Bulletins at press time

"BIG BANG" THEORY OF UNIVERSE MAY BE WRONG, if infrared measurements made from a rocket 100 miles above the earth mean what scientists think they do. The new observations indicate that the night sky is far brighter than predicted by radio observations. "Big Bang" hypothesizes that the universe was formed from one great mass which exploded and expanded to its present size. Three years ago scientists at Bell Telephone Labs in Holmdel, N.J., announced that they had discovered the "residual glow" of the primordial explosion, reasoning that the original light waves had stretched to lengths resembling radio waves. Measurements taken with the telescope reveal an intense, uniform infrared glow that is considered to be too strong to coincide with the "Big Bang" hypothesis. At press time, only one observation has been made; results are still inconclusive.

SUICIDE RATE 1,000 A DAY. The World Health Organization (W.H.O.) just announced that more than half a million suicides are registered every year and that there are at least eight times as many suicide attempts. The daily average amounts to at least 1,000, according to "Prevention of Suicide," W.H.O.'s new booklet, which uses statistics gathered by international experts. It's available for $1.25 at the American Public Health Assoc., 1740 Broadway, N.Y., N.Y.

SPACE AGE CAVE-DWELLERS LIVE 48-HOUR DAYS. Experiments with conditions that future astronauts may have to endure recently revealed that man has a tendency to adopt a 48-hour day when he has no means of gauging time. French scientists near Nice have sent two volunteers down into the 200-foot-deep Olivier Cave where they remained separately for two months. After an initial period of disorientation, the volunteers fell into 48-hour cycles of 36 hours of work followed by 12 hours of sleep. Scientists had suspected the natural tendency to live in 48-hour cycles under these conditions, but the cave experiments produced the first data resembling proof.

Is yours the special kind of mind that has to know...

. . . what causes the sun's coronas—both near and far? What curious phenomena they create in Earth's atmosphere? What part the sun plays in the five ways the world may end?

. . . that the world's smallest monkeys—pigmy marmosets—are the size of mice, weigh a few ounces, are talkative, snippy.

. . . how computers are programmed to draw pictures? How sketches like the one here, drawn by an electronic brain in London, was a key tool in solving problems in a study of human factors?

Then, for your kind of mind there is a special magazine:

SCIENCE DIGEST

—crammed with news of fascinating expeditions, discovery and research, reviews of reports in science journals and books. Best of all, it is written in non-academic language and designed to provide a cross-fertilization of ideas in business, in the lab, in school—or just to satisfy the curiosity of that special kind of mind. Find out by sending in the coupon below.

Please don't forget your zip code

Science Digest 250 West 55th Street New York, N.Y. 10019

Please enter my subscription to Science Digest for

☐ 1 Year at $5.00 ☐ 2 Years at $9.00

☐ Bill me (or) ☐ Payment is enclosed

Name_____

please print

Address_____

City_____ State_____ Zip Code_____

In Canada, add 50c for each year. All other countries, add $1.00 per year. Clip out coupon here.

WSD9A1

SCIENTISTS ARE ON THE TRAIL OF ANOTHER NEW ELEMENT, and attempts to find traces of it already are under way at Lawrence Radiation Laboratory in Berkeley, California. Hints of its existence in cosmic rays were revealed to physicists in tracks of high energy particles obtained on a high-flying cosmic ray balloon flight. The new, long-lived element is thought to be related to platinum, but heavier. If found, the new element may hold a key to the secret of atomic structure, and provide a whole family of unheard-of substances that may exist far out in the universe.

TWO NEW VOLCANOES DEEP IN ANTARCTICA have just been discovered by American scientists in Marie Byrd Land. The twin mountains spout steam from cones thought to consist of a weird mix of ice and ash. The newly found peaks fill a gap in the chain of volcanism that rings the Pacific, linking up with two active volcanoes in the McMurdo Sound area -- Mt. Erebus, a spasmodic shooter of fireworks, and another on Deception Island.

DAILY CALORIE ALLOWANCE FOR ADULTS LOWERED. The Food and Nutrition Board of the National Research Council now suggests a reduction of calorie intake for adults. Because of an increasing tendency to overweight in American adults, probably due to less physical activity, the Board's recommended dietary allowances for the "reference man" (22 years old, 154 pounds, moderately active) have been reduced to 2,800 calories daily. The 1964 allowance was 2,900 calories. Daily intake of the "reference woman" (22 years old, 128 pounds, moderately active) has been reduced from 2,100 calories to 2,000.

A CAR THAT RUNS ON NATURAL GAS, thereby cutting its smog contribution 90 percent, has just been developed by the Pacific Lighting Systems Company in Los Angeles. Engineers revealed that the system can be applied to ordinary production automobiles at a conversion cost of about $200 if done in volume. Cars with the unit can operate on normal fuels as well. The driver can switch from one fuel to the other by flicking a switch. Gas would be used in heavy traffic; liquid fuel in open country. There is some power loss under gas operation, but this is offset by cost savings.

Riddle of the 'Viking' cryptograms

Did Vikings or pranksters carve the American runestones? Clues may lie in accurate deciphering of the runic messages—and anyone can take a crack at it. This article tells you how.

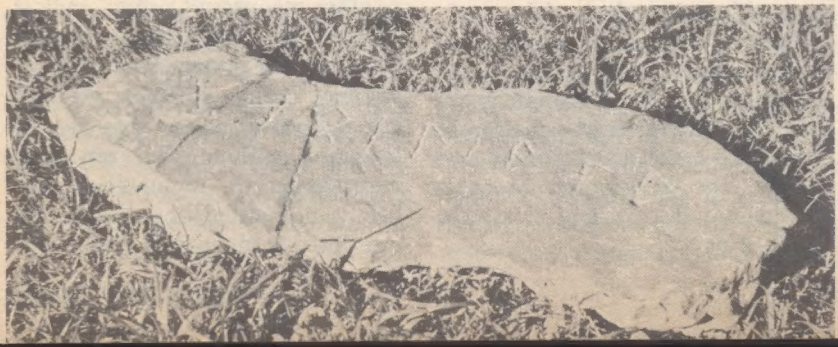
by Mark A. Roberts

THE BATTLE over who discovered the New World first—Christopher Columbus or Scandinavian explorers—started at the turn of the century when Olaf Ohman, a Scandinavian immigrant farmer, claimed that he unearthed, enmeshed in the roots of a yew tree on his woodlot, a large stone that was carved with medieval runes (alphabetic symbols used by ancient Teutonic peoples, particularly the Scandinavians). The stone was discovered near Kensington, Minn. —an area heavily populated by Scandinavian descendents and immigrants—and has come to be known as the Kensington Stone.

Since the Swedish farmer's discovery, opposing camps of opinion have sprung up all over the country —for that matter, all over the world. The fire of controversy, involving experts and laymen alike, has been fed, in part, by unscholarly investigation techniques and a glossing-over of unexplained aspects of the Kensington find.

Erik Wahlgren, in his book *The Kensington Stone, a mystery solved,* is representative of the skeptics of the stone's validity. His book does not particularly set out to prove that Columbus was indeed first to

Poteau Runestone, once part of a hillside ledge, was discovered in Poteau, Oklahoma.



Heavener Runestone detail shows three runic symbols which are six to nine inches high and about a quarter of an inch deep.

the New World. Rather, it systematically goes about the business of disclaiming the stone as having been carved by Swedes or Norwegians in the year 1362 (over 100 years before Columbus) as members of the opposite camp believe. The Scandinavians may have been first —but the Kensington Stone, according to his evidence, is not legitimate proof.

The other side of the argument is fought just as vehemently. The principal champion of the Kensington Stone's authenticity has been the Norwegian-American writer, Hjalmar Rued Holand. His articles, essays and other writings have persistently defended the stone since 1907. And although he has been accused of sloppy or unscientific techniques in his investigation, it is through him that much of the initial information was obtained—some of it quite substantial.

There is still just too much unexplained evidence—sloppy or not—that supports the "Scandinavians First" theory to let the matter be buried. To make matters more perplexing, the Kensington Stone is not the only discovery of its kind in North America.

Through the years, two other runestones have been discovered, one in Nova Scotia and another near Bourne, Mass. Skeptics have also had to contend with a carving of a 14th century knight of the Orkney islands upon a stone near Westford, Mass., and two rather similar medieval axes found in separate locations: Beardmore, Ontario, and Rocky Nook Point, Mass.

Recently, a Laval University exploration team discovered indisputable evidence of a Viking longhouse on the Ungava peninsula in northern Canada, which they have dated between the 11th and 12th centuries.

Add to this one of the most persuasive arguments for proponents of Viking exploration of North America—the World Map of A.D. 1440, allegedly drawn by Scandinavian explorers. Known commonly as the Yale Vinland Map (found in 1957 in Europe by a New Haven, Conn., rare book dealer, Laurence Witten), it now is part of the rare document collection in the Beinecke Library of Yale University.

The map, 11 by 16 inches, was discovered bound in with 21 manuscript pages; but five holes in the parchment map, inflicted by bookworms, did not coincide with holes in other manuscript pages—indicating that the map belonged to some other volume. Later when the rare volume *Tartar Relation* was discovered, it was proven that the map belonged within. The wormholes matched exactly, the notations were determined authentic, and the map was dated at about A.D. 1440.

Vinland, as the Vikings called it, began at the most northern part of Labrador and extended 2,200 miles south—or as far as Florida. There is no dispute over the belief that the Vikings were great explorers, but even the Yale Vinland Map has been questioned by certain authorities on the subject.

But now the battle must turn far inland, for in Oklahoma there are not one but two major runestones. The location of these runestones is in East-Central Oklahoma, near the Arkansas border. One lies within a cliff-enclosed vale high up on a mountain near the town of Heavener. The second stone was removed from a hill near Poteau, Okla.

For those skeptics of Norse exploration inland to Minnesota, the runestones in Oklahoma already have proven to be a tougher nut to crack than the Kensington Stone in several ways.

As with Yale's Vinland map, nature provided an aid in giving an air of authenticity to Oklahoma's runestones—in this case the lowly lichen. Lichen is particularly slow in growth. The inscriptions on both stones contained a solid lichen growth within and on the edges.

The discovery of the Heavener Runestone was made by Choctaw Indians in the 1830s when Oklahoma was "Indian Territory." The Choctaws did not think the runes looked like anything Indian, but then the "civilized" white man arrived on the scene and explained to them that the inscription was Indian writing. With that conclusion, the Heavener Runestone passed into the 20th century with the label of "Indian Rock."

In 1923, C. F. Kemmerer of Heavener wrote the Smithsonian Institution for information about the inscription on "Indian Rock." Though ethnologists at the Smithsonian were interested enough to exhibit the Kensington Stone in 1948-49 at the institution, the staff in 1923 brushed off the Heavener inscription as being done by someone with a "Scandinavian Grammar" as a guide (that is the current argument being used against the Kensington Stone).

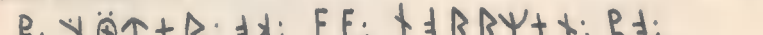
Rediscovering a stone

Had it not been for the work of Mrs. Gloria Farley, the Heavener Runestone might well have passed into another century known as "Indian Rock." In 1948, she also inquired for information from the Smithsonian and was referred to the answer given Mr. Kemmerer. But, she asked, just how would a Choctaw or an even earlier Indian have had access to a Scandinavian Grammar? Mrs. Farley began to dig deeper into the riddle: She studied runic writing, Norse history and, above all, made the local citizens aware that "Indian Rock" might be much more than it seemed.

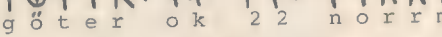
Rediscovering the stone was quite another matter. It is 12 feet high, 10 feet wide and 16 inches thick, standing upright like a monolithic billboard not much more than two miles from Heavener. However, this

The Kensington Stone

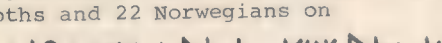
Kensington Stone translations tell story of exploration and death. "AVM" has been shown to mean "Ave Maria." This, as well as the date at the end, has been questioned.


8 göter ok 22 norrmen på

8 Goths and 22 Norwegians on


oppaselse farp fro

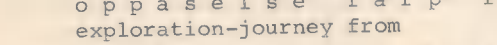
exploration-journey from


winland of west wi

Vinland over West We


hape lager wep 2 skjar en

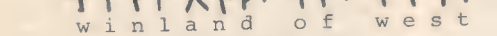
had camp by 2 skerries one


pags rise norr fro peno sten

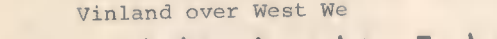
day's journey north from this stone


wi war ok fiske en pagh äptir

We were and fished one day. After


wi kam hem fan 10 man rope

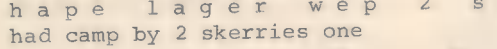
We came home found 10 men red


af blop og pep AVM

with blood and dead AV(e)M(aria)


fräelse af illy

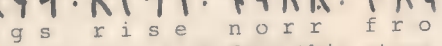
Save from evil.


har 10 mans we hawet at se

have 10 men we have at the sea


äptir wore skip 14 pagh rise

to look after our ship 14 days' journey


fram peno öh ahr 1362

from this island year 1362

runestone stands in the center of a deep ravine, surrounded by steep cliff-like walls, and the ravine is situated on an upper crest of 2,500-foot-high Poteau mountain.

The major turning point in the work occurred on September 28, 1959, when at the invitation of Mrs. Farley, representatives of the Oklahoma Historical Society met with Frederick Pohl, noted Norse scholar who published a translation of the Kensington Stone in his book *The Viking Explorers* (page 10 of this article). The meeting concluded with official recognition that the inscription was composed of valid rune characters and that the possibility of its being pre-Columbian was "of sufficient credibility" to warrant intense investigation.

The following years brought the expected amount of criticism, but the work of verifying the runestone's authenticity, according to its investigators, easily outpaced its opponents. In fact, the only "modern" explanation that could be found involved a French expedition operating under John Law's colonization scheme for the Mississippi Valley. A portion of that expedition entered the Arkansas River area in 1718-20, and one group was led by a Swedish captain. Just as the Kensington critics made much of Olaf Ohman's ancestry, the theory of the critics seems to be "a Swede found is a runestone explained."

But again, easy explanations do not stick that easily to the Oklahoma runestones. In September 1967, two junior high school boys, Henry McBride and Mike Griffeth, discovered the second runic inscription on a hill near Poteau, Okla., about 10 miles from Heavener. Knowledge of the combined runes of the two inscriptions would certainly have made that Swedish captain a most unusually advanced scholar in the 18th century—sufficient anyway to merit mention in the records of the expedition.

Now, to my favorite aspect of the Oklahoma runestones: Though the Kensington Stone is still subject to academic attack, everybody agrees that one possible translation was completed, (with some unfortunately critical grammatical errors and dubious assumptions) by Hjalmar Holand. Such is not the case with the runestones in Oklahoma. Though there have been several plausible translations offered on the Heavener inscription, there is still a good possibility that the message has yet to be translated. And with the more recently discovered Poteau Runestone, there has been only one serious attempt at translation.

Translating and deciphering is the one field of science always open to the armchair-amateur, and they have scored some notable achievements, too. Michael Ventris, an architect, deciphered the Minoan Linear B. script; and a major contribution in the deciphering of Cuneiform was accomplished by Henry Rawlinson, a military advisor. So—let's get on with the problems and techniques of runic cryptography on the next page.

How good is YOUR cryptography?

The following pages provide three basic runic alphabets, along with attempted translations of the questionable inscriptions by several scholars. If you're a word puzzle fan, here's a chance to try your hand.

THE TASK of translating runic symbols is not an easy one, but if you like word puzzles it can be fascinating. Here are a few of the problems that make even the most expert cryptographers' work subject to doubt—and give credence to the work of almost any amateur who knows what he's doing:

• There are at least a dozen runic alphabets, all distinctively different (the three provided here are the ones important to the inscriptions in question, the Heavener and Poteau Runestones, since they were most often used during the period when Vikings would have had to carve the American runestones to make them valid. It doesn't mean that other runes might not have been used, however).

• Once runic characters are deciphered into letters, they can't just be strung together into tidy English equivalents. You must run through a labyrinth of medieval language forms: a variety of ancient Scandinavian forms; Germanic; early and middle Anglo-Saxon—of which every island in the North Sea and Atlantic had its own variation.

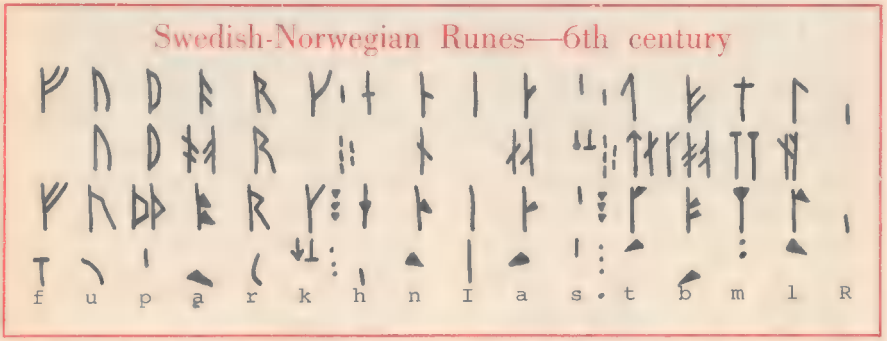
• Each of these language forms carried different meanings and shades of meanings for similar symbols. Hence the cryptographer must go through all of them in a wide variety of combinations to arrive at the most logical translation for a given runic message.

• In many cases, the oral language carried quite different meanings from the formal written (engraved) symbols. Hence, literal translations make little sense and often contribute to serious error. The would-be cryptographer must go to source books for the subtle differences in rune interpretation.

• To complicate matters, in many early Scandinavian runic inscriptions, each rune was used not as a letter in the alphabet, but as a symbol for a complete word—a sort of Viking shorthand, or code. In such inscriptions, this practice sometimes involved the entire inscription, or was partially used, in combination with alphabetical usage.

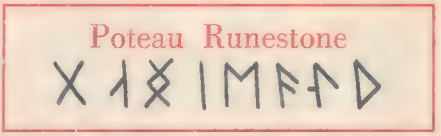
• Once you are over this morass of problems, and have come up with a mysterious, or senseless jumble, you may suddenly find that it does indeed make sense if you turn everything backwards and start over—because *some* runic inscriptions were made from right to left!

While space limitations do not permit the kind of course material necessary to provide complete history and instruction for this sort of thing (books have been written on the subject), the basic data on these pages will be enough to get you started. The bibliography at the end of the article is designed to start anyone who is really interested in pursuing the puzzle seriously off on a fascinating quest.



Three runic alphabets (above) from separate geographical areas and periods in time show how complex runic study can be; there are at least a dozen of these alphabets. These, however, are the most important in relation to the runestones in question.

Heavener Runestone has been translated, "Sun Dial Valley." What do you think?



Poteau Runestone might mean, "November 11, 1017," but there are other possibilities.

Perhaps my own experience with the Oklahoma runestones will help to give you an idea of where to start. First, the limited number of runes in the Heavener and Poteau inscriptions offers a strong possibility that the messages were written in a "shorthand" or code. One translation by Alf Monge and O. G. Landsverk is a cryptographic solution involving calendar dates rather than words. The solution is explained in their book, *Norse Medieval Cryptography in Runic Carvings* by Norseman Press. My own approach to translating the Heavener Stone was an example of a shorthand solution:

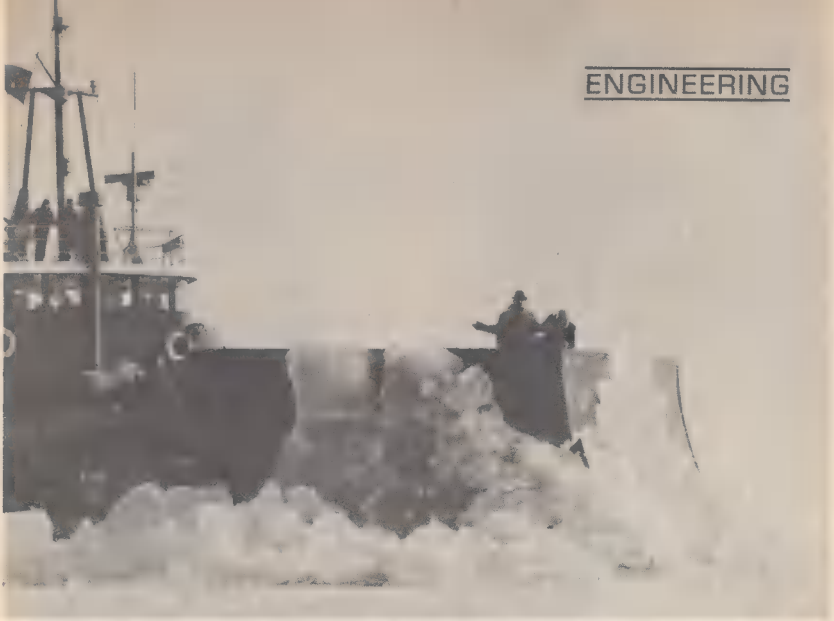
The ᚷ which leads off both inscriptions was taken as a monogram for St. Andrew, a logical patron saint for such an exploration. The ᚾ — deciphered as "N," by others, but which I can't agree with — I translate as "A." And in old Anglo-Saxon, "A" stands for "always." The real guessing game in shorthand runes comes with ᛟ, which is usually "O." I use "O" as shorthand for the Old English '"on," which stood for "with." I even project it further (with reason based on accepted meanings of the time) to stand for "on Ealdor," which would mean "with king" in more modern English. And so we eventually come up with something like: "(May) St. Andrew always (be) with King Medoth." Where's the logic in this? There are many old tales of a Prince Medoc of Wales who led his people to a new land far west across the sea. Unless it is confirmed through translation of another inscription, such as the Poteau stone, mine is just a calculated guess. But it was fun, and the goal merits the effort. It indicates, here, the free-association—involving language, history and anthropology —that must be brought to bear in this kind of cryptography. The key to an answer may come from anywhere.

As impossible as the task appears, there is little doubt that future translations will be made that will help solve the riddle of American runestones. Even if no new stones are discovered, the Vinland argument will most certainly be expanded further than either side of it ever anticipated. Perhaps your own efforts will shed new light, or at least expose an overlooked corner of the mystery.

So, if cryptography intrigues you, start deciphering. And good luck!

Bibliography

For further information on Runes: Encyclopædia Brittanica, Vol. 19 pp. 659-664, 1956. *The Prose Edda by Snori Sturlson,* Brodeur, Arthur G., American-Scandinavian Foundation, 1923; *An Icelandic-English Dictionary,* Cleasby, Richard and Vigfusson, Gudbrand, Oxford, Clarendon Press, 1874; *Vikings in America: Theories and Evidence,* American Anthropologist, LVII (Feb., 1955); *Introduction to Old Norse,* Gordon, Eric V., Oxford, Oxford University Press, 1927; *The Kensington Runic Inscription,* Hagen, S.N., Speculum, XXV (Summer, 1950); *America, 1355-1364,* Holand, Hjalmar, New York, Duell, Sloan and Pearce, 1946; *Researches Concerning the Institutions and Monuments of the Ancient Inhabitants of America etc.,* Trans. by Williams, Helen M., London, Longman, 1814; *Greenland Runic Inscriptions* I-IV, Jonsson, Finnur and Moltke, Erik, Copenhagen, Reitzel, 1924; *Norse Inscriptions on American Stones, Collected and deciphered,* Strandwold, Olaf, Weehauken, N.J., Magnus Björndal, 1948; *A Concise Dictionary of Old Icelandic,* Zoëga, Geir T., Oxford, Clarendon, 1926.



Breaking the ice may no longer be as big ■ headache as it once was, thanks to ■ lifting and plowing type icebreaker called Alexbow (above) made by Canadian company.

Breakthrough in ice breaking

ICE-CLOGGED shipping lanes have always been a headache to shippers, but a new icebreaker called Alexbow may bring some long-overdue relief.

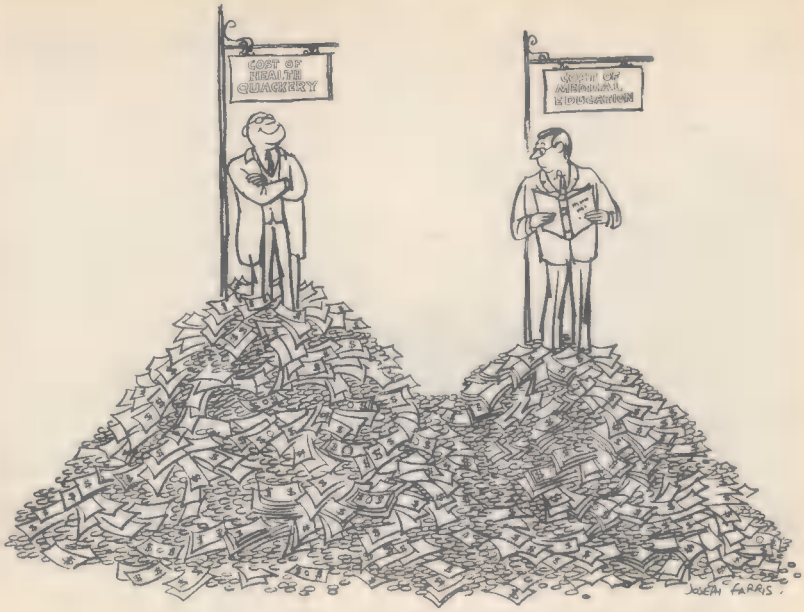
Designed by Scott E. Alexander of Ottawa, Canada, Alexbow uses a radically different bow configuration for icebreakers, reminiscent of the ram-bow of 19th century warships.

It works on the principle of lifting and plowing from beneath the ice, scattering the jagged chunks across the solid, frozen surface. This cuts down on floating ice—so dangerous to plates and propellers of cargo vessels.

Conventional icebreakers b u l l their way through areas of ice using brute force; there is tremendous impact as they ride up onto the ice to force it to b r e a k downward against water resistance. This dissipates the power of their turbines.

But Alexbow works with nature instead of against it. Contact is made with the ice without shock. As the ice is lifted, lateral pressures are released, and the broken ice tumbles to the port and starboard.

The Alexbow design has several possible configurations that include detachable bows pushed by a tug or small ship and permanent installations on full-time icebreaker ships. It may even extend Arctic shipping seasons to as long as five months instead of the usual six to eight weeks.



Quacks—the would-be MDs who can harm you

Medical quackery is big business today, costing more than health education. The unfortunate prognosis is that it will continue to eat away at victims' pocketbooks and health.

by Barbara O'Connell

"OF COURSE I can cure you," the swarthy, white-coated man assured his diabetic patient. "The Spectro-Chrome can cure any disease." He pointed to an impressive-looking metal box with a lighted opening on the side. To effect a cure, he explained, the light in the box was directed at the afflicted parts of the body during the phase of the moon indicated by the patient's ailment. His patient, an elderly man, was so convinced by the machine and the white-coated man's manner that he hardly bothered to protest when he was advised to stop taking his daily insulin shots. "You won't need them," he was told.

With high hopes, the diabetic dis-

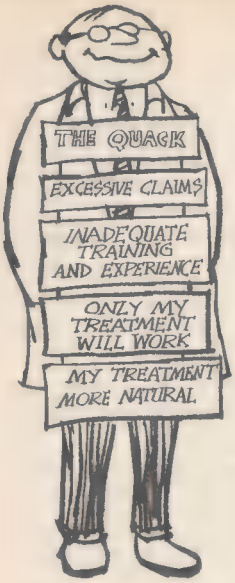
continued his shots and began daily treatment with the Spectro-Chrome instead. In a short time he lapsed into a diabetic coma and died.

His death would probably have passed unnoticed if the Federal Food and Drug Administration hadn't been hot on the trail of the white-coated man, "Colonel" Dinshah P. Ghadiali. A native of India, Ghadiali had only an honorary medical degree to his name—and even that was spurious. But his lack of qualifications didn't stop him from prescribing Spectro-Chrome therapy for diseases ranging from heart disease to diabetes. He had invented the machine over 25 years before and eventually sold over 10,000 of them at $475 apiece. When he was brought to trial an FDA official demonstrated that inside the Spectro-Chrome was a 1000-watt light bulb, in front of which colored panes of glass were slid to "treat" various ailments—red and purple for heart disease, purple and blue for cancer, and so on.

The trial also brought out the story of Ghadiali and the diabetic. When all the testimony was in, the Spectro-Chrome inventor was fined $20,000, put on probation for a few years and distribution of his machine halted. Ghadiali, then 75, never went on trial for his part in the death of his diabetic patient; when his probation was up, he went back to his old trade—quackery.

Ghadiali is a prime example of the modern-day quack—s l i c k e r, richer and, surprisingly, more plentiful than ever, even in these days of modern medical science. Webster's New International Dictionary (1959 edition) defines *quack* as "a boastful pretender to medical skill; a medical charlatan; an ignorant or dishonest practitioner following a simple empiric system to treatment of disease." Quacks take many forms today. There's the quack practitioner, like Ghadiali, who prescribes for ills he knows little or nothing about. Often the quack practitioner uses his own or other quack machines or devices—but so do some licensed physicians! The FDA reports finding a number of quack devices in the offices of gullible but fully-licensed physicians with degrees from first-rate medical schools. Quack drugs are plentiful, too, as are quack cosmetics, quack health books, quack health columns and articles and quack health lectures. And let's not forget the quack manufacturers who make the dubious drugs, devices and health foods which other quacks foist on the public.

How many people in the United States are killed or injured as a result of quackery? The swindled are reluctant to talk and the dead can't, but John Miner, chief of the Medicolegal Section of the District Attorney's office in Los Angeles, calls health quackery "public crime number one." "It steals more money and injures and kills more people than any other criminal action," he declares. Miner is the prosecutor in a case that may have far-reaching implications for such practices. Linda Epping, a Cali-



fornia child with a fast-growing cancer of the eye, was slated for an eye operation in a California hospital. Before the operation, her parents removed her from the hospital and took her to a chiropractor who told them he could cure her without surgery. He treated the cancer until the child became so ill that her frightened parents took her back to the hospital. She died in a short time. California has charged the chiropractor with murder—the first time a murder charge has been made in such a case. The defendant was convicted but is now appealing.

The usual charge in such cases has been manslaughter. In 1965, the state of Florida tried two chiropractors for manslaughter in the death of a man with pulmonary tuberculosis. His ailment was diagnosed by a physician, but the man refused treatment and consulted the chiropractors. Treated without drugs (chiropractors, by law, cannot prescribe drugs) and put on a vegetarian diet interspersed with fasts, the man died of tuberculosis within a year. Medical witnesses at the trial testified that the disease could have been arrested or controlled if the patient had been treated by approved medical methods and given available drugs. The defendents were convicted. A few years earlier, another Florida court found a chiropractor guilty of manslaughter in counseling a diabetic patient against the use of insulin.

As most of these cases make plain, quacks and quack treatments usually do not kill directly; what they do is defer authentic medical treatment until it's too late. Death or permanent impairment of health can be the result. "The cancer patient who resorts to Krebiozen, Koch, Hoxey or Laetrile treatments may well be sentenced to death since he loses the one element in his favor—time," says Douglas C. Hansen of the Food and Drug Administration. The treatments he names are unproven and unaccepted cancer "cures."

"Well," the lay person may retort, *"I'm* not seriously ill so what's wrong with my going to Dr. Dubious? He makes me feel better." Hugh H. Hussey, M.D., the director of the Division of Scientific Activities of the American Medical Association, points out that the layman is hardly capable of deciding whether or not he's seriously ill.

At best, the person who consults a quack or takes quack treatments

will lose money—perhaps a lot of money. Ghadiali's patients paid him $90 to join his "Spectro-Chrome Institute" and $250 for an introductory course in "Spectro-Chrome Therapy." He had 10,000 paid members. Quackery is big business in this country. Estimates of its gross in any one year in the U.S. range from one to two billion dollars. If the larger figure, the American Medical Association estimates, is accepted it means, according to the organization's president, Dwight L. Wilbur, M.D., that "the cost of health quackery is more than the entire cost of health education. In addition, it is more than the cost of all medical research done in this country." The FDA's Douglas Hansen gives more specific figures. "Perhaps 400 million dollars a year are being spent needlessly for therapeutic vitamins. Well over 100 million dollars a year go to buy false and fraudulent weight-reduction schemes."

How can you tell a quack from the qualified health practitioner, if quacks are slick enough to sell useless devices even to licensed physicians? Roger D. Freeman, M.D., the director of psychiatric services for handicapped children at St. Christopher's Hospital, Philadelphia, has drawn up what he calls an "index of suspicion" for ferreting out quacks. Among the items on his index are: excessive claims without good evidence; claims to provide service for which training and experiences are inadequate; unwillingness to ascribe results to anything other than his treatment; describing his treatment as more "natural" than others. If a health care "expert" exemplifies any or all of these characteristics, Dr. Freeman thinks, he's a good man to avoid, even if he comes equipped with a medical or other professional degree.

The reasons that make some Americans put their money and their lives in the hands of quacks are mulled over frequently by physicians, psychiatrists and others interested in the field of health. Douglas Hansen thinks that the facts of modern medical science have fostered a climate of creditability in which the quack's pronouncements seem hardly more remarkable than the latest authentic medical wonder. People read about vitamins and rush out to buy bottles of them, convinced that if 50 units are good, 500 must be better.

Psychological motives

Dr. Freeman describes possible psychological motivations for a belief in quackery. "The need to believe something which is untrue may have deep roots which are quite inaccessible to education and persuasion," he says. "There are also those who align themselves against the 'Establishment.'" Many such people are paranoid, according to Dr. Freeman. If you tell them the facts about the quack they patronize, they'll be angry at you and defend the quack. Some forms of quack treatment may be popular, too, because they meet specific individual

needs more effectively than accepted methods. "Nude psychotherapy" provides sexual gratification and even more conventional therapy groups produce much-wanted friendships.

Chiropractors are particularly successful with those who are dissatisfied with their physicians, Dr. Hussey of the AMA suggests. "The successful chiropractor is a salesman," he says. "He tells his patients what they want to hear and, further, that his methods are just what his patients need—that nothing else will do. Unlike the physician, he never says, 'Leave it alone and it will get better,' or 'Take two aspirin tablets, stay quiet and call me tomorrow.' The chiropractor attracts the ignorant, the fearful and the dissatisfied neurotic."

Help for the neurotic victims?

What's being done to protect the ignorant, the fearful and the neurotic, as well as the American who reads health books "for fun" and takes vitamins "just in case?" Not much. Beginning in 1906, when the first Federal Pure Food and Drug Law was passed, the Federal Government has been empowered to move against quacks in limited ways. The Federal Food and Drug Administration controls the labeling of drug products, including references to drugs in print or on the air. The Kefauver-Harris law gives the FDA the power to compel drug manufacturers to show proof that their new products can do what is claimed of them before they are marketed. The Federal Trade Commission combats false and misleading advertising. The Post Office moves against mail frauds involving health products or treatments.

But Federal cases take a long time to prepare and a verdict may be delayed for years while the quack goes his merry way. States, too, run into delaying tactics when they prosecute quacks. The answer to quackery, for many people in the health field, is a combination of regulation and education. In the forefront of the education movement is the AMA, which publishes a battery of pamphlets and data sheets on practices they regard as quackery. In Chicago this past October, the AMA held its fourth annual Congress on Quackery, a meeting that brought together government, medical and business experts to discuss quackery and how to control it.

Even more important in combating quackery, thinks Dr. Freeman, is the attitude of the licensed physician himself. When medical men are impatient, contemptuous or abrupt, the patient may react in a negative fashion, becoming more vulnerable to the unethical practitioner "who at least knows how to listen." He suggests training young medical personnel so that they realize the importance of human needs and feelings and establish a "truly helping relationship" with the patient. "Such a relationship," he says, "is perhaps the best immunization against quackery."

Science Month

Sandstone carving of Egyptian musicians was recovered from Akhenaten's temple in Thebes, capital of ancient Egypt. Temple was built to honor Aten, god of the sun.

Computing a temple

In ancient Egypt, a pharoah's religious preferences became the preferences of his people—while he lived. King Akhenaten, or Ikhnaton, who ruled Egypt from 1367 B.C. to 1350 B.C., was a monotheist who built a temple to Aten, the sun god. When Akhenaten died, his successor, Tutankhamen, re-established the traditional gods and Aten temple was destroyed.

Between 50 and 100 years ago, some of the old buildings at Thebes, the ancient capital of Egypt, underwent reconstruction. In the foundations and walls of these buildings, workers found sandstone blocks cut to uniform size. The blocks were inscribed with scenes and hieroglyphics. Archaeologists studied the blocks and deciphered the name of Akhenaten. Apparently these were the blocks that had once formed Aten temple.

Eventually, about 35,000 of the sandstone blocks were found and stored in warehouses.

Now a group of scholars and businessmen from Arab and U.S. institutions are using cameras and computers to determine how Aten temple looked 3,300 years ago. They photograph each block, code it on an IBM card and feed the cards into a computer at the IBM office in Cairo. To put the stones themselves back together would be too difficult, so the group hopes to reassemble the photographs in a visual reproduction of Aten temple.

"We are piecing together a gigantic jigsaw puzzle, too difficult, time consuming and complex for solution by the human brain unaided," says

Dr. Froelich G. Rainey, director of the University Museum of the University of Pennsylvania, one of the organizations involved in the project. He calls Aten temple "one of history's greatest structural achievements."

The pictorial reconstruction of the temple will take at least a year or two, experts estimate. When it's completed, the temple is also expected to provide more data on the little-known reign of King Akhenaten, whose queen was Nefertiti.

Eruption brigade

A volcano watch for United States volcanoes is urged by the chief Federal geologist, Dr. William T. Pecora. "There are a number of volcanoes in the Cascade chain that could become explosive and damaging if they become active," he says.

Among the mainland U.S. volcanoes that have what Dr. Pecora calls "eruption potential" are Mount Rainier and Mount St. Helens in Washington state, and Mount Lassen and Mount Shasta in California. Only Mount Lassen is classified as active, but so-called "dead volcanoes" sometimes erupt. Arenal Volcano in Costa Rica, dormant for some 500 years, erupted last July and several "dead" volcanoes in Iran went into action in August.

"Believing that the volcanoes are 'dead' because there has been no recent activity is 'out of sight, out of mind' thinking," Dr. Pecora says.

A volcano watch would pick up the tell-tale signs that precede eruptions so that residents of the area could be warned, he notes. He recommends a network of seismic instruments placed near suspicious volcanoes to take measurements several times a year and remote sensors in planes or spacecraft.

Giant fused silica mirror for astronomical telescope has 86-inch diameter. Fused silica is used because it changes shape very little during extreme temperatures, cutting down optical distortion. Built by Corning Glass Works, Corning, New York.

Rear-end collision inviters

Certain types of drivers have certain types of accidents, studies are beginning to reveal. In tests of Washington, D.C., cabdrivers, it has been found that drivers who react slowly at first, then with quick movements, have more accidents in

BIPS

Training dogs to obey in city traffic is done by conditioning them with a stream of water. Developed in Germany, training technique includes realistic stage scenery, real traffic lights and noises and narrow stream of water. Dog associates traffic noise with being sprayed in the face. Also sprayed when traffic light isn't in his favor. This negative reinforcement conditions dog to usual safety rules.

which they are struck from behind. Such drivers tend to jam on their brakes suddenly and get hit by the vehicle behind them.

In another study, subjects were tested on their ability to stop suddenly when a dummy pedestrian appeared in their path. Six months later, members of the same group were tested in a darkened room on their ability to move a luminous rod into a vertical position while a luminous frame was tilted first to one side and then the other. The subjects who did better at positioning the rod also did better at hitting their brakes when they saw a pedestrian.

Such persons are quick at extracting figures from their backgrounds and analyzing them properly, the researchers explain. "Field independency," as it's called, is also affected by alcohol and age. People who have been drinking and those under 21 are more field dependent than others. Women, too, tend to be more field dependent.

Where are those pulsars?

Pulsars, those ever more mysterious radio signals from outer space, may come from outside the Milky Way Galaxy, according to British and Australian observations. Now the pulsars are thought to be in a vast "halo" of stars which surrounds our galaxy. The new observations, made at Britain's Jodrell Bank Observatory and Australia's Molonglo Radio Observatory, indi-

Hairless mouse is the result of controlled breeding of naturally occurring mutations born without hair. Hairless mice are bred only with other mutations to produce specimens for research in cosmetics, dermatology, cancer and other skin problems.

cate that former estimates of the distance from the earth to pulsars had been much too short. To project radio pulses over the great distances now postulated would imply energy comparable to the entire output of the sun, concentrated into short, rhythmic radio pulses.

Murder by chromosomes?

Daniel Hugon, a 32-year-old French stablehand, seems to be a born loser. Outsized and dull, he was ridiculed in grade school, which he never finished. At 16, he was caught stealing and made the first of several suicide attempts. By the time he was 25, he was an alcoholic drifter. Then, three years ago, he murdered a prostitute in Paris.

This fall, Hugon went on trial in Paris for murder with an unusual defense. Because of an inherited chromosome imbalance, his lawyer maintained, Hugon was not responsible for his acts. Dr. Leon Derobert, a highly-regarded professor of legal medicine, testified that Hugon's life history indicated he was a "sick man" from birth. He suggested a protective environment in the custody of a guardian and treatment with tranquilizers.

The prosecution countered that thousands of people with chromosome imbalance lead law-abiding lives. At best, it was contended, a chromosome aberration was only a

contributing cause of crime.

While prosecution and defense battled in the precedent-setting case, Hugon sat almost expressionless with his hands tightly clasped to keep them from trembling. Interrogated by the judge, he said: "I don't care what the verdict is—I just want to be freed of my nightmare." He had attempted suicide twice in prison.

The nine-man jury, composed largely of professional men, took less than 40 minutes to reach a verdict: guilty. Hugon was sentenced to seven years.

The abnormality exhibited by Hugon is known as the "XYY." It means that he has an extra male chromosome, "Y," a phenomenon that happens about once in every 2,000 male conceptions. Such males are usually aggressive, anti-social, tall and dull. Recent studies in the U.S. and Britain show that chromosome abnormalities are much more prevalent in men convicted of violent crimes than in the general population. (See *Science Digest*, June 1968 and December 1967.)

Although Hugon was convicted, an accused murderer in Australia with a chromosome abnormality was acquitted recently. Both cases will probably be cited in the appeal of Richard F. Speck, the convicted murderer of eight nurses in Chicago. Speck, whose physical and mental characteristics are those of the typical "XYY" male, was found to have a chromosome abnormality after his trial, according to his lawyer.

Before the Hugon trial, one prominent French biologist, Jean Rostand, suggested that all those with chromosomal imbalances carry cards identifying their affliction. But the Communist newspaper *L'Humanité* objected that the card would brand thousands as potential criminals.

Doughnut-shaped raindrops

A big raindrop looks like a doughnut with the hole not quite through it, a scientist observed at the University of Toronto's recent Conference on Cloud Physics. Some drops are bigger than others, due to condensation or coalescence—the joining of one drop with another. In northern latitudes, coalescence usually takes place in conjunction with the presence of ice particles in a cloud.

Next—a 'smell' wheel

There may be primary smells like primary colors from which all other smells can be made, suggests Dr. John E. Amoore of the U.S. Department of Agriculture. A primary odor would have a molecular structure that would exactly fit an odor detector in the nose. A non-primary, on the other hand, might resemble two or more primaries, activating two or more detectors and producing a blended odor. Dr. Amoore suspects 20 to 30 odors of being primaries.

TECHNOLOGY

Electron scanning microscope

SCIENTISTS can now view microscopic objects in three dimensions at magnifications from 20 to 150,000 times because of a microscope that works something like a TV set.

Called an "electron scanning microscope," this new scientific tool offers great advantages in the study of biological objects. It has a great breadth of field and depth of focus —"at least 300 times greater than the optical microscope and much, much greater than the electron transmission microscope," according to scientists at Florida State University who are making extensive use of the tool.

Because of the extreme ranges of depth and focus, it is possible to view relatively large biological objects (such as the fruit fly, *Drosophila melanogaster,* at the right, shown at a magnification of 180 times). Furthermore, the great depth of focus enables the scientist to examine closely (in 3-D) the external surfaces of practically anything from metals and polymer fibers to minute ocean organisms.

The microscope uses an electron gun that emits a fine stream of electrons which bombards the surface of

Photographs: L. M. Beidler and P. Graziadei, Florida State University

Head of fruit fly at a magnification of 180 times. Picture is obtained by photographing the image on a TV-like screen.

any object being studied. After moving the electron stream back and forth over the object, the deflected electrons are gathered; and the detected signals are used to modulate the brightness of a spot on a screen much like a TV tube.

Because of the small intensity of the electron stream, it is even possible to observe some specimens in a living state. (Previously, it was routine to cut the specimen's tissues and to prepare sections, in many cases.)

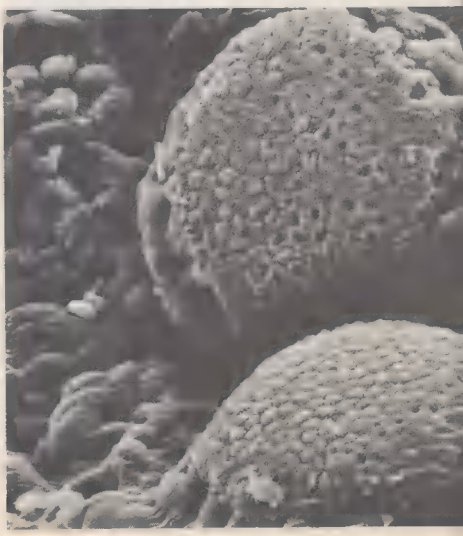
With the electron scanning device, living organisms, such as insects, can be viewed at various angles and degrees of magnification with relative ease. Changes in magnification can be made simply by turning a control knob from one setting to another.

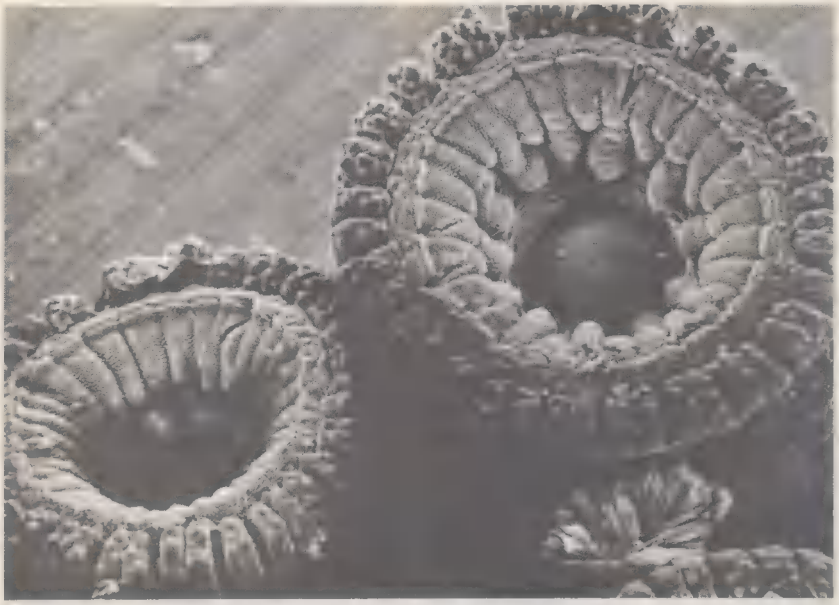
Florida State University's biology department is using the instrument to study the sensory organs of various animals; however, the variety of uses for it seems endless. Medicine, oceanography, metallurgy and geology are but a few disciplines that will benefit from this remarkable new tool for research (please turn page).

Octopus sucker (above) magnified hundreds of times shows taste receptors within.

Taste buds of a frog (right) greatly magnified show hemispheric configuration.

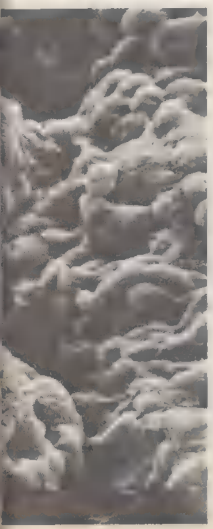
Tongue of a rabbit (below) magnified 200 times. Leaf-like structures are taste buds.





Octopus suckers (above) magnified less than photograph at left. Compare taste receptors.

Head of an ant (below) magnified 138 times. Electron scanning microscope lets scientists study living insects instead of prepared sections.



NEW FOR PEOPLE

BIPS

Heated rescue stretcher can keep a person warm for up to 10 hours, making it especially good for mountain and cave rescue work. A 12-volt battery heats the stretcher. Test-O-Therm, Nanholme Mill, Springside, Todmorden, Lancashire, England.

Portable greenhouse (right) can be put up in about 10 minutes. Dismantled, it packs into roll 4 feet long, 1 foot in diameter, weighing 23 pounds. Tubular metal sections make up frame which is covered with 1000-gauge polythene, called "Politarp." Lyndene (Boxwich) Ltd., Blue Lane West, Walsall, Staffordshire, England.

Medical magnet (right) is designed to help doctors retrieve sharp swallowed iron objects. It's inserted down throat, steered by fluoroscopic guidance to blunt end of object, switched on, removed blunt end first, switched off, far right. Developed at G.E. Research Center, Schenectady, N.Y.; will be made by Quigley-Rochester.

BIPS

Electronic thermometer (left) makes taking temperatures quick, very accurate, easy to read. The feeler, which contains heat sensitive head, is touched to person and temperature is registered on scale of box unit which holds dry cell batteries. By Braun Electronic Gmbh, Frankfurt am Main, Russelsheimer Str. 22, W. Germany.

U.P.I.

Skiing without snow is now possible. Arthur Weber (left) spreads Perma-Snow on bristled surface mat being unrolled at Grossinger, N.Y., by David Marshall. The two invented the surface, quite similar to snow.

Mini air hammer (below) weighs less than two pounds, can drive 6- to 30-penny nails. Designed, manufactured by Aerosmith Tools, Inc., Visalia, Calif. Drive pin made of a steel from Allegheny Ludlum, Pittsburgh, Pa.

ARCHAEOLOGY

Roman Palace

All photos BIPS

Marble head of a young boy uncovered in ruins is believed to be a relative of king who built palace, perhaps his son.

This seahorse motif found on ■ mosaic floor has become symbol of palace near south coast of England.

THE biggest Roman palace outside Italy is in (1) France (2) England or (3) North Africa. If you picked England, you know your ruins. In 1960, workmen laying a water main in the village of Fishbourne in England's south coast region dug up pieces of Roman tile. Since then, archaeologists have uncovered a portion of a vast palace that sprawled over six acres and included four wings enclosing a garden. The north wing is now completely excavated and open to the public, along with part of the garden, which is newly replanted.

Historians think a local puppet king named Tiberius Claudius Cogidubnus built the structure in A.D. 75 after the Romans installed him as head of the region. Tiberius probably spent some time in Rome as a youth and acquired his ideas of what a palace should look like. When he built his own, he imported mosaicists and builders and had marble brought from as far away as Greece and Turkey.

The result was a palace as big as Nero's in Rome, with mosaic tile

Classic main entrance as it probably looked is shown on model for museum.

Catwalks (above) let visitors see central heating put in after Cogidubnus died.

floors, private suites for visitors and gardens dotted with fountains. Cogidubnus lived here until his death in A.D. 100, after which the elaborate building, like many big homes today, was split up into apartments. About A.D. 270, a fire destroyed the palace.

Soon the rubble disappeared beneath farmland and, in modern times, the village of Fishbourne. The area was slated for redevelopment when a workman's shovel uncovered the tiles on which a Roman ruler walked almost 2,000 years ago.

Four-hundred-foot-long roof covers excavated north wing with mosaic tile floors.

Model (below) shows plan of six-acre palace, four wings surrounding garden.

AVIATION

Engineering shambles:

Because of weight factors, stabilization problems, radiation hazards, heat from air friction to contend with —and sonic booms— designers of the SST have a tiger by the tail.

by Devon Francis

In Seattle, Wash., an army of Boeing Company engineers is making radical changes in the design of a transport airplane that only a couple of years ago was being publicized as the final word in a machine that would fly from Tokyo to the U.S. West Coast in less than five hours; from New York to London in two and two-thirds hours; and between the Atlantic seaboard and California in one and three-quarter hours.

A continent and an ocean away, in Toulouse, France, a U.S. airline executive stares incredulously at a stainless steel windshield on another version of the same kind of aircraft. One tiny peephole has been drilled into the steel windshield.

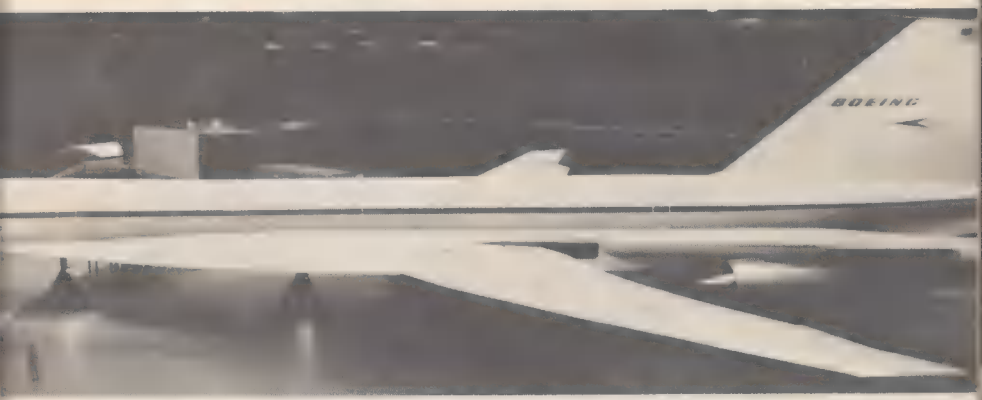
"Oh, no!" he says. "We're not buying that idea!"

An engineer for the Sud Aviation Corp. smiles reassuringly. "It's only for the test programs. The prototype windshield will be thick quartz." But the American can well be disturbed. His company has ordered a number of these aircraft, designed to fly at 1,450 m.p.h. They are far behind schedule. As early as May 1966, Sud Aviation and the British Aircraft Corp., in collaboration on this transport, the Concorde, posted a first-flight date of Feb. 28, 1968. As this is written, the airplane is still anchored to the ground.

What has become of the supersonic transport, popularly known as the SST?

It has problems. In Seattle, in Toulouse, in Filton, England, and no doubt in a laboratory outside Moscow—where the U.S.S.R. is readying its own version of the SST —the airplane that was to out-pace the sun around the world has run

the SST



U.P.I.

Boeing's SST mock-up shows the gigantic size of airplane's design when compared to man standing at lower middle. Plane is designed to fly at speeds of 1,800 mph.

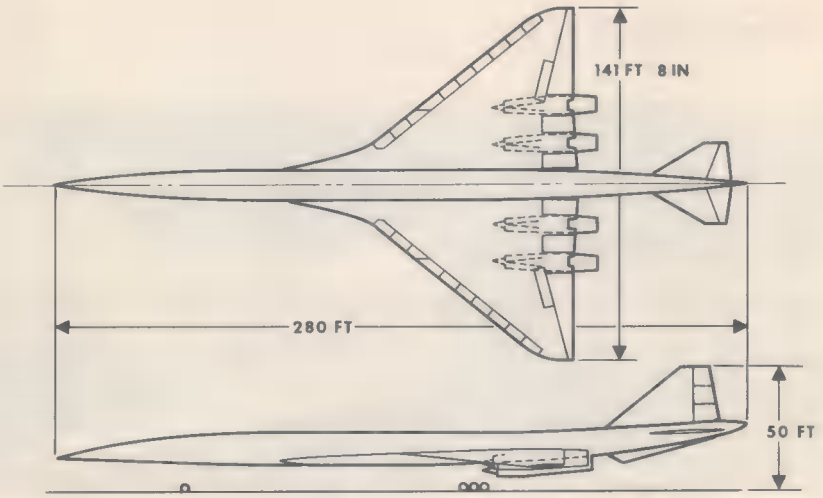
into complications. With the exception of one, they are not unsolvable. But all are horrendous.

In time the SST will arrive. Don Dwiggins, the authoritative aviation writer, titles his recent book on the subject, *The SST, Here It Comes, Ready or Not.* (See page 94, November '68 *Science Digest.*) Ironically, people are ready, but the plane is not. Why? Military SS airplanes have been notably successful—if we discount the troubled, swing-wing F-111. A Lockheed has flown at sustained speeds of more than 2,000 m.p.h., faster than the fastest of the proposed SSTs. The huge B-70, weighing more than one-half million pounds, but never put into production, also has flown at speeds beyond those proposed for the supersonic transports. The Air Force's B-58 has had little trouble flying at 1,300 m.p.h.

Part of the answer is in "scale effect," the problems that burgeon when designers boost the size of an aerodynamic shape. Part is due to an understandable ignorance of the weird phenomena attending supersonics, part in adapting the SS to the needs of traveling businessmen and little old ladies, and part are king-size design *blunders.*

It is traditional in aircraft manufacture that designers underestimate weights. In the SST this becomes a caricature. Weight profoundly affects acceptability for reasons of economy and—more important—for the effects of the sonic boom.

Boeing, with an SST that won a design contest against Lockheed on the last day of 1966, concluded belatedly in mid-1968 that the pivots



Swing-wing design of Boeing's SST has been replaced by more conventional fixed-sweep configuration. Will be built of titanium and will have wing span of about 142 feet.

for its "swing-wings" would impose a weight penalty of 40,000 pounds. This was a shock both to Boeing and those airlines with SSTs on order. Originally Boeing talked of toting 292 passengers in its model 2707, as the company labeled it. Before the swing-wing was abandoned last fall, that figure was down to less than 250.

The swing-wing model 2707 was too fat by 25 tons. The U.S. government, which is underwriting the bulk of the $1.3 billion preliminary design cost, wants a payload of 58,600 pounds and a range of 4,000 miles at Mach 2.7, roughly 1,800 m.p.h. The aircraft's swing-wing design couldn't meet these demands. Something had to give. The maximum payload range was down to 2,300 miles. It doesn't help the weight any that refrigeration tubes must be snaked through the walls of the SST to dissipate 450-500° F. temperatures induced by skin friction or, in the case of the Concorde, 180° F. at Mach 2.2.

The hydraulic system providing muscle for movement of the controls and raising and lowering the landing gear must be cooled, too. To save weight, the current thinking is to employ the cool fuel and a heat exchanger to achieve that.

Simple bending stresses on frames and skins imposed by the rigors of supersonic flight necessitated adding tons to structural weights in the Concorde and 2707.

Directional and roll (lateral) control deteriorates in supersonic aircraft at cruise speeds. And here the layman encounters a seeming con-

tradiction. Any surface of an aircraft aft of the center of gravity becomes a stabilizer in flight. This effect is compounded at Mach 2 or 3. But control suffers because air, the source of maneuvering ability, begins separating from the control surfaces at supersonic speeds.

So designers have to compromise their precious formula for maximum lift-over-drag configurations. For high speed they put their control surfaces as far aft as possible. Here they obtain the greatest leverage in their inputs on the cockpit controls for glide or climb, or turn and bank. And they make the surfaces as big as barn doors.

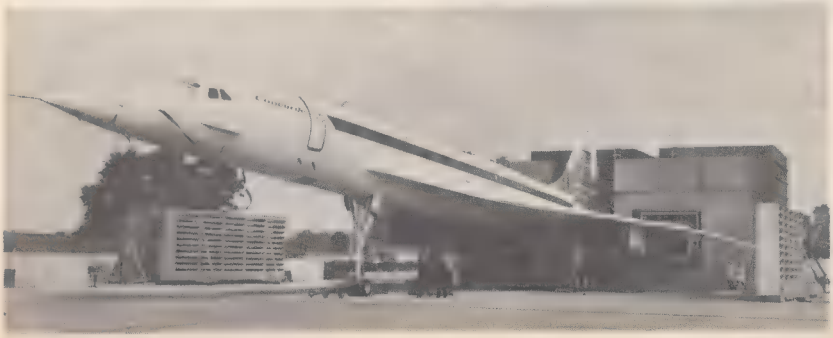
On paper, there is a simple answer to control. Just destabilize the airplane. Any surface forward of the center of gravity is a destabilizer. A canard—a small wing at the nose, which on an SST of Mach 2.7, like the Boeing, could weigh several thousand pounds—would do the trick. Boeing fed this into the computers. They reported that a canard would cause too many other problems. The slower Concorde has had to add a "moustache" up forward to prevent yaw at high speeds.

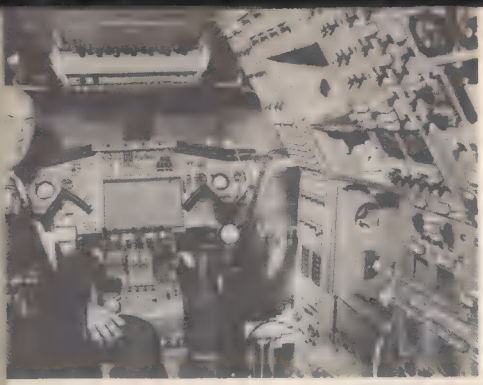
Then there is the SST's rearward shift in the center of lift on the wing as speed goes supersonic. The nose wants to pitch down. One cure for this is to move the center of gravity aft to coincide with the center of lift. The B-58 does this by pumping fuel backward. So will the Concorde. Boeing's answer was pivoted wings, extended at a 30-degree angle to the fuselage for landing and takeoff, and swept back to 72 degrees for supersonic flight. The entire configuration became an arrow. An eight-degree elevator trim rendered center of lift and center of gravity identical. Lockheed had settled on a long "wing" on the longitudinal axis, a supplementary delta, that hugged the fuselage forward and did not begin contributing lift until the craft went supersonic.

Of the fuel transfer system, one supersonic pilot commented, "So

Concorde 002 is a joint project of England and France. Identical SSTs have been built in both countries. Plane below was built by the British Aircraft Corp., Bristol, England.

Pictorial Parade





Pictorial Parade

U.P.I.

Pictorial Parade

Cockpit of the Anglo-French version of the SST, Concorde (top). Andre Turcat, a Sud-Aviation production director, is at the controls of "001," the French airplane. **Concorde 002** (middle) has massive tail section and fixed-sweep wing configuration. Plane will fly at speeds up to 1,450 mph and will weigh about 378,000 pounds. **Russia's SST** (bottom) will carry 120 passengers at speeds up to 1,500 mph. Called "TU-144," the plane has been rumored to be flying already at subsonic speeds.

you slosh all this kerosene aft to trim the plane for cruise, and what happens if you have an emergency and have to slow down? You've got an unstable airplane. It takes time for the pumps to move the fuel forward again."

The problems of passenger carriage, to make the SST a viable addition to the world's fleets of jets, opens up another nest of snakes. Will passengers get claustrophobia with a thick window only a half-dozen inches in diameter to see through? The windows must be small for structural integrity. If explosive decompression occurred, at a cruising height of 12 to 14 miles, all aboard could be dead on arrival on earth due to body fluids that boiled above 63,000 feet. In case a window did blow, provision will be made to supply supplemental pressurization, as was done in the B-70.

Passengers will get a king-size jolt of "clear air turbulence" at supersonic speeds. This is a phenomenon caused by colliding rivers of air. It spawns violent "wind shears" that wrack a plane like a rat shaken by a dog. Here there is hope. Wind shears cause heat. Experimental, on-board infrared detectors are now good for a 50-mile warning. (See "Inventions," page 69, this issue.) But the distance will have to be boosted thrice to do a pilot any good when he is covering a mile each two seconds.

Cockpit instrumentation will have to include cosmic ray detectors. With only a fraction of the protection afforded by the earth's belt of

air at sea level, an SST will get a dosage of radiation that, for some strange reason, peaks out at 70,000 feet—the SST's cruising altitude. Flight crews could absorb their allowable yearly limit in three months, and everybody in the airplane could get enough in a single flight during a solar flare outburst to last a lifetime.

So much for a sketchy look at the headaches. The overriding problem —one that can't be solved unless someone can repeal the laws of physics—is the sonic boom. This is the thunderclap spread by an airplane flying supersonically. Proportional to the energy developed, which essentially means aircraft weight, the boom causes "over-pressure" (the pressure beyond the 2,000 pounds per square foot that air exerts on the earth's surface). Booms have smashed windows and crumbled cliff dwellings in the nation's national monuments. Boom experiments in St. Louis and Oklahoma City led to angry complaints by the citizenry. A boom—actually, three separate claps from an SST's nose, wing tips and empennage in a fraction of a second—can be heard for 20 miles on each side of a flight path.

Official Washington wants the boom confined to an over-pressure of two pounds in accelerating through the transsonic, one and a half in cruise, and one and three-quarters in descent. No evidence has been adduced at this point that the criteria can be met. So proponents of the SST have stopped talking about flights over land masses—between New York and Los Angeles, for example.

The "tolerable" boom of one and a half pounds is produced by an airplane weighing 200,000 pounds and flying at a minimum of 60,000 feet at Mach 2.2. The Boeing (which two years ago weighed 510,000 pounds) grew to close to 650,000 and proposes to fly Mach .5 in excess of that specification. The Concorde (which began at 350,000 pounds) now weighs 378,000. Its Mach speed is on the nose. The Russian Tu-144 grosses 286,000 and will fly at Mach 2.3. Fuel burnoff will, of course, reduce these weights, and the magnitude of the boom, prior to landing.

What about the ship below?

To restrict the SST to intercontinental schedules will sharply curtail its usefulness. Even so, the inquiring reporter gets no answers when he asks what will happen to a glass-enclosed lounge in a luxury ocean vessel when an SST passes overhead in a climbout at the two and a half pounds over-pressure that the Federal Aeronautics Administration proposes to permit on over-ocean flights.

Last January Boeing asked for another year to complete its design work on the 2707. It had a tiger by the tail. Major changes already being made include a fixed, delta-shaped wing.

When the Concorde people announced last winter that the Feb.

28, 1968, first flight date had been a mere "public relations" projection, nobody bought the fiction. When return lines on a plane's hydraulic system rupture and have to be replaced with heavier tubing, it is symptomatic of thousands of problems.

Disciples of the U.S. SST concept are devout. The plane has to come, if only to maintain a niche in the world's exploding technology. But critics of it are brutal. More than five years ago, at the time President Kennedy blessed the project, the Stanford Research Institute stated that the SST had no economic justification in its opinion.

Asked how he would like to fly an SST, a U.S. airline captain exclaimed, "Fly it! I wouldn't even ride in it!"

The U.S.S.R. plane and the Concorde were scheduled to enter service in May 1971. What the design problems have done to their calendars remains to be seen. Rumors abound that the Russian SST already is flying subsonically. The Boeing, starting three years behind the Concorde, is now four years tardy by choice and, on the present curve of progress, could not reach service before 1976 to 1977.

"Beat it will you!"

New home for old bones

EXOTIC mammals that once roamed the plains and forests of ancient North America will be housed in a new wing of the American Museum of Natural History in New York City.

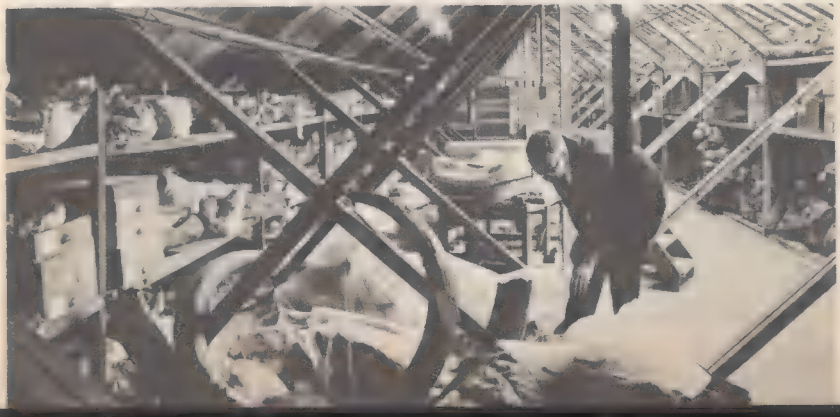
More than 250,000 mammal specimens, the result of 46 years of fossil hunting, have been willed to the museum by the Childs Frick Corp., an organization founded by multimillionaire paleontologist Childs Frick. The corporation also provided funds to maintain the collection and help build the new wing.

The gift is the biggest in the museum's 99-year history, and almost doubles its number of fossil vertebrate specimens.

A three-horned deer, a mummified mammoth and a three-toed horse are among the outstanding specimens in the collection. The extinct ancestors of the dog, cat, camel, rhinoceros and elephant are also represented.

The quality of the fossils is unusually high because they were excavated by large-scale quarrying operations below weathered surface layers, the museum points out.

Every fossil, no matter how big or small, was cataloged at the dig-



—American Museum of Natural History

Dr. Malcolm C. McKenna, curator of Frick Collection, which is to be housed in new wing of Museum of Natural History, examines, at right, bones of sloth's feet and, below, specimens now in storage.

ging site. The cataloging supplied a reference number, a description of where and when the specimen was found and a geological picture of the area.

The key to the system is contained in 80 loose-leaf notebooks in a cabinet at the museum. All of the Museum's Childs Frick records are now on "a couple of miles of microfilm," as Dr. McKenna, Frick curator, expressed it.

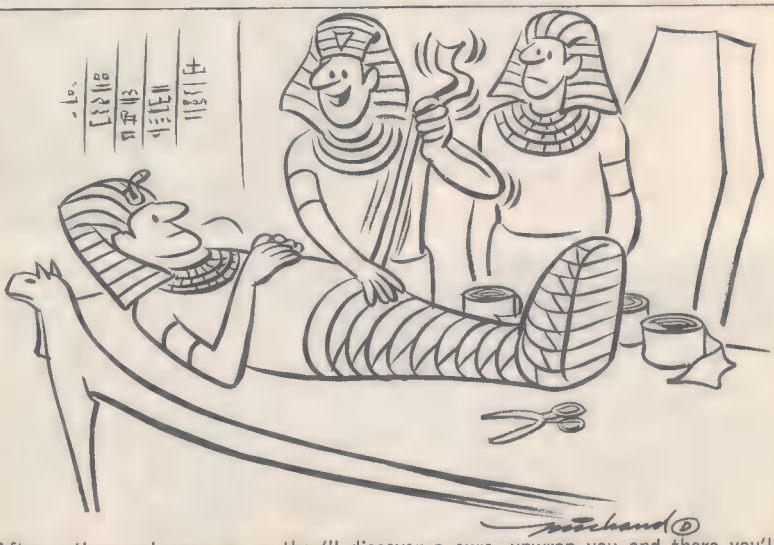
The fossils themselves, all of which are already at the museum, are stored in bins, cases and file cabinets on the museum's fifth and sixth floors. Bigger fossils are under tarpaulins in an attic area and in the basement.

Frick field research parties scoured North America, as well as some sites in Asia and South America, in search of specimens for the collections. The cost of the collecting is estimated at over $6 million.

The scientists brought back more than 7,400 crates of fossils, about 90 percent of which have been opened and the fossils removed from the sandstone and clay surrounding them.

Many "lifetimes of work" still remain to be done on the fossils, however, according to one of the curators of the collection.

Progress in understanding the vertebrate life of ancient North America will be "intimately linked" with research on the Frick Collection, according to museum scientists. It's doubtful, they note, that a similar collection can ever again be amassed because many of the virgin fossil localities explored by Frick expeditions will never again be available for excavation.



"After a thousand years or so they'll discover a cure, unwrap you and there you'll be . . . good as new."

Miniature TV has screen as small as a quarter and operates on batteries or current from wall outlet. Designed by Westinghouse, TV uses microminiature components, circuitry.

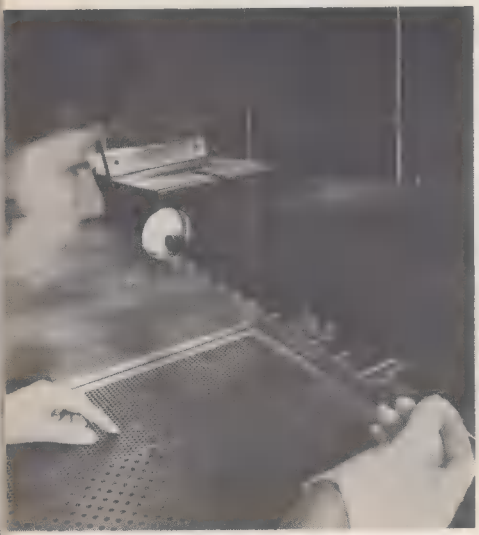
SCIENCE DIGEST SPECIAL

LSI: Micro-mini circuits

Electronics is in the midst of a revolution that will have monumental effects on everything from industry to housekeeping —all because of "micro-mini" circuits.

by Arthur S. Freese

A TELEVISION SET, the size of your smallest transistor radio, with a picture tube as big as a quarter; a two-way radio no larger than a woman's wrist watch; an audio amplifier small enough to fit into a nutshell with room to spare; a TV camera (the size of your eight



mm. movie camera) for use on the moon. These are no wild-eyed dreams—they already exist! In the foreseeable future you'll vote for President right in your own living room; there will be electronic devices sufficiently miniaturized for doctors to implant hearing aids within your body, or monitors of bodily functions; there will even be computers small enough to fit into the handset of your telephone. "Large scale integration" (LSI) will make all these products available to you—and so soon that industry is already gearing up to mass-produce these devices.

For several years now, scientists have known that by 1970 every American will be personally affected by an electronic revolution which was thought to have reached its peak with the first "integrated circuit" (IC). These devices are made of tiny wafers of silicon, the second most abundant element—some 25 percent—of the earth's crust. Silicon is always present in sand as a chemical compound, but for electronic purposes it must be 99.999 percent pure. From prepared tiny wafers of this element, chips are cut or "diced" into pieces about the

Computerized coordinatograph (top) is used to cut "mask" or circuit design. Later design is photographically reduced to micro-mini size on silicon wafer. See p. 53. **Silicon slices** (middle) go through heat treatment process where vapors deposit a very thin film of single crystal silicon. **Each silicon slice** can produce as many as 1,000 separate circuits. Device (bottom) etches narrow slots between the circuits.

size of this letter "o" and barely thicker than a human hair.

Each chip can replace a complete electronic circuit formerly made with some 50 separate components —transistors, resistors, capacitors, diodes and all the wiring and connections needed to make them work together. On a wafer the size of a half-dollar, technologists can put as many as 1,000 circuits. This is the third generation of electronic devices, following the vacuum tubes (first used for radio transmission and reception more than fifty years ago) and the transistors.

In the 1930s, Bell Telephone Laboratories began the research which resulted in the production of the transistor. In 1939, that same company built the first working automatic digital computer, the "Complex Computer," in New York City. The following year, mathematicians at Dartmouth College in Hanover, N. H., sent mathematical problems to this machine via teletype and received their answers in the same manner. The first general-purpose automatic digital computer was a Harvard IBM machine which started working in April 1944 and continued for many years to handle urgent military computations on a 24-hour-a-day, 7-day-a-week basis.

However, it was in 1946 that the first automatic *electronic* digital computer, the ENIAC ("Electronic Numeric Integrator and Calculator"), was completed at the University of Pennsylvania by a team headed by Dr. John W. Mauchly. This was a room-sized machine with 19,000 vacuum tubes. These electron tubes were then the only devices that could amplify electrical signals. Made in many sizes and for varied purposes, they did their job remarkably well; but they were bulky, fragile, relatively short-lived, power-hungry and costly; furthermore they gave off a great deal of heat. The first transistors offered no advantage in size and were even more costly; it took years for these new devices to prove themselves—their greater reliability, longer life and remarkably low power requirements as compared to the preceding vacuum tubes. However, starting in the mid-50s, transistor prices dropped sharply.

Transistor boom

On Dec. 23, 1947, Bell Telephone Laboratories' scientists John Bardeen, Walter H. Brattain and William Shockley proved that a tiny piece of germanium could amplify a speech signal some 40 times. So important was this transistor effect that, in 1956, they were jointly awarded the Nobel Prize in physics for their discovery. The transistor, a solid-state device of semiconducting material, is used to control or amplify electrical current. Some one million of these devices were produced in the United States in 1954—300 million in 1962.

But in 1955 transistors had not converted a single major item of military electronics, and industrial uses were virtually limited to hearing aids, although the first transistor

radio did come out that year. These solid-state electronic devices are now used everywhere from the bottoms of the seas to the farthest reaches of man's probes into space, from wrist watches to locomotives, from TV sets to industrial equipment, from missiles to hospital operating rooms. Giant computers contain over 100,000 of these devices connected together so that these machines can perform millions of calculations per second. In a recent study to "see" how molecules react chemically, a computer did 100 billion separate additions and multiplications!

Tiny citizens band receiver was developed by Westinghouse. Powered by a six-volt battery, CB can receive signals transmitted by conventional walkie-talkie at ranges up to one mile. Extremely small size was possible because of miniature circuitry.

About this same period in the mid-50s, as Steve Guthman, marketing manager of Westinghouse's Molecular Electronics Division, explained to me, the first grouping together of several electronic components was tried. This technique came out of the laboratory-curiosity level in 1958 when the U.S. Air Force, in a pioneering contract with Westinghouse, turned to a radically new approach to achieve greater reliability. Thus was born a short-lived generation of electronic devices, the integrated circuit. These ICs put more electronics into a smaller area, functioned more reliably and cost less than previous systems.

An electronic computer's entire circuitry can be constructed from a teaspoonful of these minute ICs. They improved the reliability of electron circuitry by a ratio of 10 to one. The life expectancy of those now in use has been estimated at some 20 million hours, over 2,000 years. Even longer service can be expected from LSI. Mr. Guthman described how the original integrated circuits were "very medieval" in terms of the technology that developed only two or three years later. They were big, lumpy, multi-chip affairs where one chip was a combination of resistors and another carried a combination of active devices (power and signal transistors), with a confused jungle of interchip wiring between. The electric layout was coarse and the chips were more than twice the size of today's. In early 1962 several manufacturers

began commercial production: only some 10 to 15 thousand were turned out during the entire year. Yet, five years later 100 million were produced!

The manufacture of integrated circuits is done in surgically clean rooms by capped and gowned workers, often wearing rubber fingers or gloves. All this in an atmosphere of pressurized air to maintain a dirt-free environment because a single speck of dirt can be larger than a working section of one of these devices. Temperature and humidity too are carefully controlled, and the equipment is automated to a considerable degree. Microscopes and vacuum pencils are used to process and handle the tiny wafers and the minute dice.

Mr. Guthman estimates that, when first introduced, 99 percent of ICs went to the government; now only some 50 percent does, with 40 percent going to the industrial market and 10 percent to the consumer, principally in hearing aids but also in home equipment such as clocks or portable radios. The government is using some of its ICs in missiles and F-111B planes, the Navy Mark 48 torpedoes and sonar submarine detection devices. These tiny electronic appliances have made possible the TV camera which the astronauts will soon take with them to the moon: not much bigger than an eight mm home movie camera, it can withstand temperatures from 250° F. to 33° below zero.

But before the technology of integrated circuitry had a chance to ripen, scientists presided at the birth of a new electronic era—that of "large scale integration." A whole generation of electronic devices, the IC, has been virtually skipped. Engineers never got a chance to accustom themselves to the uses, possibilities and techniques of IC before a new and better—and more complex—device was upon them. Where IC puts 1,000 circuits on a half-dollar-sized piece of silicon, LSI can put 100,000. Technologists can even squeeze close to 1,000,000 transistors and resistors into a square inch!

LSI brings 'design automation'

LSI hardware has four advantages: compactness, greater reliability, higher speed and lower cost. Computers were designed using vacuum tubes and transistors much as you do with Heathkits, and the technologists continued this method with ICs because they hadn't the time to readapt their thinking. At this point, LSI was thrust upon them, and the old techniques now *must* change. The complexities and miniaturization of LSI make necessary a new specialty called "design automation."

In fact, LSI has produced visions of such vast dimensions that the scientists talk of it in terms not heard since the discovery of the laser. They are said to range in their thinking from sheer awe at the prospects to absolute panic ("LSI means LSD for circuit designers").

Typical of the excitement and

Three Lions

Amplifier for "bugging" device is small enough to fit between Lincoln's nose and chin on a U.S. penny. Compare its size to the size of the amplifier in your home hi-fi or stereo, which probably uses transistors, tubes and printed or wired circuits.

hearsay produced by this revolution is a story said to have been rumbling around the industry for the last few years—a hearing aid to be placed in the space left by the removal of two large back teeth. But coming down to earth, if that is possible in this new world, a Westinghouse spokesman foresees LSI in 90 percent of all computer applications in the next five years. The present IC market in the United States amounts to some one-half billion dollars, and Westinghouse projects a market of a billion dollars in 1975 with LSI being a third of this. The representative also sees the LSI cost objective as two cents a bit (an electronic circuit) while five cents a bit is right ahead now: the equivalent amount of circuitry in IC today would cost 60 cents; in transistors, $1.50!

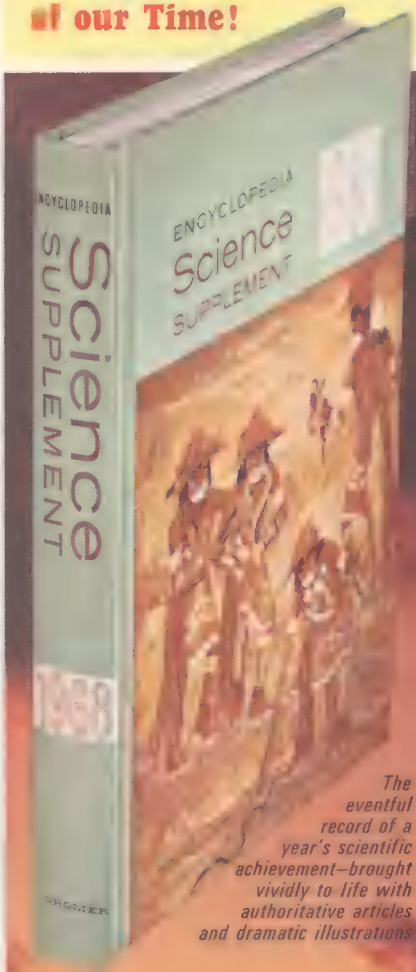
The silicon for these devices is produced in the same manner as lasing material such as ruby. A rod is introduced into a carbon crucible of molten silicon and as the bar is withdrawn, a rod of silicon is "pulled." The final form, a foot or two long, is some one and a quarter inch in diameter. This is sliced by a diamond knife, like so much bologna, into wafers which are then polished or lapped to a perfect mirror-like finish, with no imperfections. These wafers then go into a furnace to be heated and exposed to vapors which deposit a thin film of single-crystal silicon.

This crystal film is then "doped"—a special gas adds minute amounts of the right kind of "impurities." These new atoms diffuse into the red-hot silicon to produce the desired electrical properties; dopants are added to exact parts per billion. Following this, the wafer is steam-treated to cover it with a protective layer of inert silicon oxide which is then covered with a light-sensitive layer. This surface is exposed to ultraviolet light through a photomask (much like making a photoprint) and then the exposed areas are etched away. In the next furnace, another impurity is diffused through the windows thus created—then once again coated with the protective oxide.

(Text continued on page 53)

The BIG Science Book That Lets You Enjoy and Understand the Exciting Events of our Time!

yours to pre-view FREE!



The eventful record of a year's scientific achievement—brought vividly to life with authoritative articles and dramatic illustrations

The ENCYCLOPEDIA SCIENCE SUPPLEMENT

CREATED BY THE EDITORIAL STAFF OF ENCYCLOPEDIA AMERICANA AND GROLIER, INC.

THE ENCYCLOPE

Especially designed for:

STUDENTS who must keep abreast of science progress

TEACHERS who need a reliable source of scientific knowledge

EVERYONE interested in the excitement of science today

SPECIAL:

Pre-view it FREE for 14 days! No obligation to buy. Return the if you are not pleased and owe nothing.

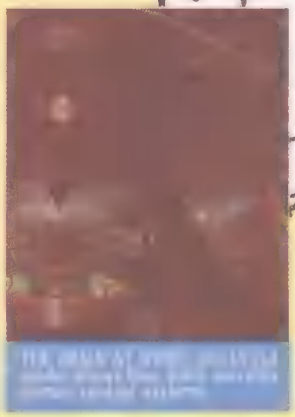
MASADA—A major archaeological expedition throws light on the seige of a tragic citadel.

CONTINENTS — How the great land masses were formed and how they are moving.

THE PLANET JUPITER — What science knows and what it hopes to find out about the largest planet.

BUTTERFLIES AND MOTHS — How this important order of insects affects other forms of life.

THE RORSCHARCH TESTED — Psychologists now think twice about the value of the famous "inkblot" personality test.



INFORMATIVE ARTICLES COVERING THE MAJOR FIELDS OF THE YEAR'S SCIENTIFIC DEVELOPMENTS:

- Archeology
- Anthropology
- Astronomy
- Biology
- Earth Sciences
- Health & Disease
- Man and His World
- Physical Sciences
- Mathematics
- Psychology
- Space
- Exploration
- Technology
- Transportation
- Communication
- Projects and Experiments

The Whole Story of an Exciting Year of Science Progress in One Compact, Illustrated Volume—the ENCYCLOPEDIA SCIENCE SUPPLEMENT for 1968!

Return this card for FREE 14-Day Examinatio

• 440 Exciting Pages • 70 Authoritative Articles • Over 360 Illustrations including photographs, drawings, charts and graphs • 24 PAGES IN FULL COLOR

DIA SCIENCE SUPPLEMENT

Now, instead of reading dozens of costly, highly technical publications, you can find all that's new, important and fantastic in this one lavishly illustrated volume. Now you, too, will be able to discuss — with authority — such scientific breakthroughs as:

- Why murder by "Black Magic" is no longer considered a laughing matter.
- A "vaccination" against Cancer?
- What psychoanalysts say is the real, hidden danger in the use of marijuana.
- New studies underway reveal how the food you eat may save your heart.
- How you can see new 3-D "living" pictures without special eyeglasses.
- Discovered . . . how animals "talk" to one another.
- Scientists scratch their heads as torrents of rain fall whenever the Hopi Indians perform their grisly Snake Dance Ceremony.
- How weather forecasters will help feed the hungry via space age science.
- Now . . . bodies become "batteries" in a new chemical treatment for heart patients.
- What is the "EB" Virus and what part does it play in the "kissing disease"?
- Why may a case of the "blues" lead to a cold in the head?
- Canadian botanists "revive" plants that bloomed 10,000 years ago.

A PARTIAL LIST OF ARTICLES APPEARING IN THIS NEW SCIENCE REFERENCE:

WATER—Important facts about a familiar compound.

CONSERVATION—The problems and costs of preserving natural resources for tomorrow.

THERMOGRAPHY IN MEDICINE — An infrared photographic technique that has become a valued medical tool.

THE SCHOLAR FROM ALGERIA — He developed the first philosophy of history 600 years ago.

CREATIVITY — How creativity reveals itself and why it should be encouraged.

PITIRIM ALEXANDROVITCH SOROKIN — A great sociologist and researcher dies.

THE SILICONES—An account of some highly versatile chemical products.

AGGRESSION — Can man overcome his instinct for warfare?

UNITED NATIONS ASTRONAUT RESCUE TREATY — A report of an international agreement dealing with the peaceful exploration and use of outer space.

THE NEW PICTURE OF VENUS —Space probes and radio telescopes reveal new facts about the Earth's sister planet.

THE HISTORY OF COMPUTERS — Man's aids to computation and memory from the abacas Fortran and Cobol systems.

HOLOGRAPHY — The photographing of three-dimensional images.

THE PIRI RE'IS MAP — Could Renaissance maps be copies of others thousands of years older?

- - - - - - - - - - - - detach along dotted line—no postage needed - - - - - - - - - - - - -

01 – 90026X

Americana *MUNDELEIN, Illinois 60060*

Without obligation, please send me, for 14 days **FREE EXAMINATION,** the **1968 ENCYCLOPEDIA SCIENCE SUPPLEMENT.** In 14 days I will return it and owe nothing, OR, I'll send you only $5.95 plus a few cents for shipping and handling. I understand that by keeping my copy, you will register me to receive automatically, future editions of the **SCIENCE SUPPLEMENT** for a period not to exceed five years. The SUPPLEMENT will be mailed to me at my guaranteed price 30 days after I receive an announcement of the latest edition. I am free to cancel this privilege at any time.

Name _____
(Please Print)

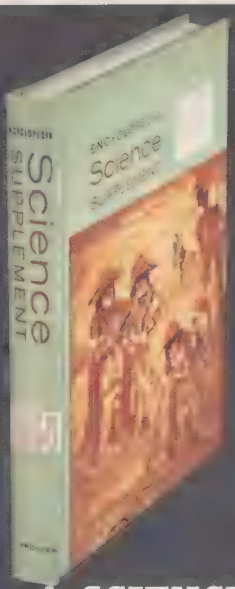
Address _____
(Please Print)

City _____ State _____ Zip _____

Signature _____ Phone No. _____
(must be signed by adult to be valid)

If you have an account number with us please write it here: [ ]

SAVE! Enclose your check for $5.95 and we pay shipping and handling. Same Free Trial privilege with full refund guaranteed. Illinois residents add 30¢ Sales Tax.



A SCIENCE REVIEW

— in one complete authoritative volume!

Pre-view it FREE for 14 days!

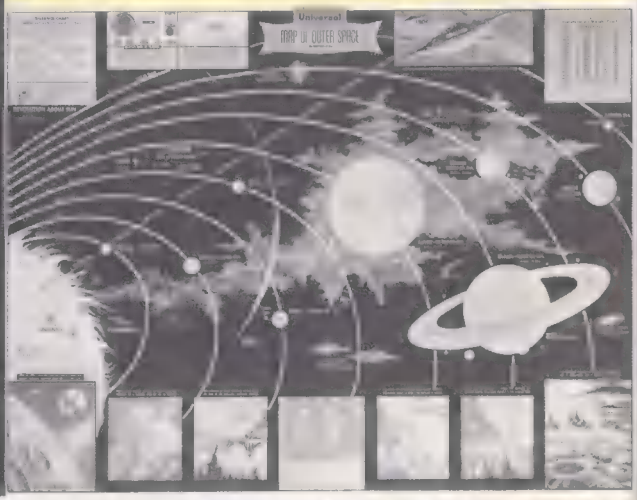
YOURS FREE!

Huge 33" x 42" Full-color WALL MAP OF OUTER SPACE — worth $2.00.

Picture wall map is packed with such fascinating information as: an Interplanetary Weight Chart (find out how much you would weigh on different planets), a Space Ship Time Schedule, a Radar and Radio Communications Distance Chart, pictures showing Sun's relationship to the nine planets and much, much more!

When you preview the ENCYCLOPEDIA SCIENCE SUPPLEMENT you may keep the Wall Space Map whether you purchase the book or not!

It's a perfect decoration for Den, Recreation Room or youngster's room . . . and so educational too! Remember—it's YOURS TO KEEP whether you purchase the ENCYCLOPEDIA SCIENCE SUPPLEMENT or not!



FIRST CLASS
Permit No. 34
Mundelein,
Illinois

BUSINESS REPLY MAIL

No Postage Necessary if Mailed in the United States

Postage will be paid by —

Americana

MUNDELEIN, ILLINOIS 60060

This process is repeated until all the circuit elements for a complete electronic circuit have been formed repetitively across the surface of the wafer. A diamond-tipped scriber scratches a grid of fine lines between the rows and columns of circuits and the wafer is drawn across a sharp straightedge to break it into possibly a thousand chips or dice, each a complete circuit. After testing, lead-in connections are attached and the whole encapsulated in metal or plastic—the final IC. These can withstand centrifugal tests at accelerations of 20,000 g's (about that of a well-hit golf ball as it takes off from the tee).

Each circuit, whether for IC or LSI, must begin with a design; this is drawn on a set of acetate masks usually two or three feet square, virtually photo-negatives. These masks, which may soon be made with lasers, are some 400 times the dimensions of the final product. Cut to an accuracy of 2/10,000 of an inch (1/10 the thickness of a human hair), the mask is reduced by a photographic process to proper size. One set of these negatives may reproduce a circuit up to 1,000 times on a half-dollar-size silicon wafer, and the immense complexity will necessitate computer-generated designs.

The masks actually used are glass plates on which the pattern, in its final size, appears as a thin opaque film. Bell Laboratories engineers estimate that by the early 1970s their Allentown Laboratory will have to supply 1,000 masks a month as compared to the present 160.

The first major application of ICs was in the Air Force's Minuteman 2 ICBM program in 1962 when an improved missile was needed to deliver a heavier payload over a longer distance. Rather than undertake the expensive and long-drawn-out process of building a better propulsion system, it was decided to try to alter the electronic guidance system by lightening it through the use of ICs. The idea was successful, and the government gave out a nine million dollar contract for nearly a half-million of these devices. Integrated circuits by the many-thousands have gone into the Phoenix air-to-air missiles, the Univac computer airborne computers for antisubmarine warfare, Marine tactical data systems, Army facsimile equipment and forward area secure-communications systems.

Technological explosion

LSI has taken the electronic circuitry of the IC and multiplied it by 10, 100 or even 1,000. So rapidly is this change taking place that the technologists are having difficulty in keeping up with themselves and often cannot make the complete swing from IC to LSI but stop at "hybrid" circuits. These use not complete but partial integration, not putting everything in the same chip. Capacitors, for example, are only passive elements of electrical circuits; while they are the cheapest elements in the old transistor or

vacuum tube systems, they are the most expensive in the new integration because they take up considerably more real estate on the silicon surface than the other elements. As Mr. Guthman explained, it's much cheaper to use an ordinary 11-cent capacitor and wire it to the balance of the circuit on the chip: even the world's largest computer, the IBM 360, uses hybrid circuits.

The future promises rapidly increasing large scale integration with fewer individual parts. The electronic elements will be closer, producing faster operation, for reducing the distance the current must traverse will make a difference. Light travels through a vacuum at about one foot in one billionth of a second (a nanosecond). For a circuit to operate in a few nanoseconds, the elements must be no more than fractions of an inch apart.

Electronics' Alice-in-Wonderland

The present and the future, the IC and LSI, are inextricably intertwined in this Alice-in-Wonderland world of solid-state electronics. Mr. James S. Locke, vice president of Honeywell's Micro Switch division, predicts that "Americans may be able to vote for President in 1988 without even leaving their homes . . . 'Instant Elections.'" Honeywell's computer keyboard looks like an ordinary typewriter but each key magnetically activates an IC. Educators anticipate that in the late 1980s well over 100 million people will be able to use computers. Honeywell's 8200 large scale computer is another commercial application of LSI.

Mr. Locke foresees that the businessman of the 1970s, yes even the housewife, will "talk" to computers and be relieved of many boring routines. Typing out a brief message on this keyboard will do your shopping, keep your household budget and checking account, even make out your income tax. Your vacation —transportation, hotel accommodations, theater tickets and dining reservations, sporting equipment— could all be arranged just as you would type out a letter today.

Dr. Edgar A. Sack, general manager, Westinghouse Molecular Electronics Division, explains that equipment has already been developed to pay monthly bills by inserting a personal credit card into a telephone and dialing a prescribed code. Apparatus at the bank would automatically debit your checking account and credit the account of the creditor prescribed in the dialed code.

Computers are today revolutionizing medical care, diagnosing patients (even to psychiatric problems!). They will assist with medicine dispensing as well as records and will monitor patients so that close, personal nursing won't be necessary. Westinghouse has already built a television receiver the size of your small transistor radio and its picture tube is as big as a quarter; also a two-way wrist radio about as big as a woman's wrist watch. The next step could be elec-

Microminiature TV camera will be used to send pictures of the moon's surface when astronauts make their landing. Westinghouse Defense and Space Center has developed TV camera for NASA. Live broadcasts of the flight to the moon, on the lunar surface and the return trip will be made over commercial television networks. Artist's drawing shows how astronaut will transmit TV pictures back to earth. Camera development was made possible by LSI (Large Scale Integration) which does away with conventional tubes, transistors, wiring.

tronic alarm systems to be carried in your vest pocket—these will send out an alert to police or hospital, depending on whether there is a dangerous situation or a medical emergency. Your location would be accomplished automatically.

Hughes Aircraft uses these miniature electronic devices in attack computers to direct guns, rockets, missiles and bombs. ICs are used in ground-to-air tactical radars of only some 50 pounds.

With less than one-fifth of the 11,000 separate components and 30,000 connections needed for numerical control systems to automate milling machines, punches and complex positioners working in three axes, Westinghouse uses ICs and LSI to build the same controls. In fact the complexity of machine

tool controls have virtually made them small computers, and in this area LSI will find one of its major uses.

Then there will be the future communications devices which will bring you your morning newspaper, radio and TV on a laser beam—the TV will be flat and hang on the wall like a picture. Another area of use for these solid-state devices will be in your car which you will enter, set controls and then play cards or watch TV while the car drives itself safely, by the shortest route, to your destination. They will also operate the auto's automatic temperature controls, dim its lights, and operate the distance sensing equipment and speed-up and slow-down techniques.

Dr. Sack points out that "major technical effort brought the integrated circuit from a crude laboratory gadget to a sophisticated production-line product, all within the space of about five years. That effort is sure to continue."

That effort has produced LSI—the electronic way of the future!

Electronic evolution can be easily shown by comparing, left to right, large vacuum tube which took a long time to warm up, and wore out rapidly; transistor with protective can, which at one time seemed to be the last word in electronic technology, but is now archaic; and a tiny integrated circuit. Developed by Bell Telephone Laboratories, Murray Hill, New Jersey, IC has 22 transistors and other components and is self-protecting.

Significance of LSI to industry, business and professions

• *Computer*—Without this industry, there would be no modern technology or science. In 1967, the number of general-purpose digital computers passed the 50,000 mark for the first time and 90 percent were U.S.-made. Computers of the future will be so miniaturized by LSI that they will fit into the handset of a telephone.

• *Agriculture* — The computer may also change the farmer's life. A desktop or telephone computer will take over much of his drudgery.

• *Automotive*—New electronic devices will allow you to enter your car, set the controls and then either play cards or watch TV while the car proceeds safely to your destiny.

• *Aviation and Outer Space*—The guidance systems of airplanes are now using ICs (integrated circuits) for automatic handling, communications and distance calculations. Attack computers use LSI to direct bombs and missiles. These new devices will provide 80 percent of the Apollo moon camera electronics; the entire spacecraft is a major user of LSI and ICs.

• *Consumer Goods*—LSI has made possible TV sets the size of small transistor radios, and wrist radios the size of women's wrist watches.

• *Electronics* — LSI is revolutionizing this science. An IC (the size of the letter "o") carries a complete electronic circuit with as much as 50 separate components—transistors, resistors, capacitors and diodes. LSI can carry even 100 times as much.

• *Inner Space*—Computers with LSI are essential under the seas. Sonar detection equipment also utilizes ICs.

• *Machine Tools*—LSI will find one of its major uses in this field. The complexity of machine tool control has become so great that only IC and LSI have made electronic control economically feasible.

• *Medicine and Dentistry*—LSI opens the way to miniature probes which can be implanted to monitor bodily functions such as pulse, temperature, breathing.

• *Military*—LSI will have a tremendous impact here. Vast changes in telemetry systems will occur as a result of this new ability to put so many electronic circuits into a small area.

• *Politics*—You will vote in your living room by 1988 and no one dares even guess what effect this will have on politics, candidates and elections.

NEW FOR INDUSTRY

Microwave reflectors (above) on California mountain top send data back and forth between Lockheed Missiles & Space Co.'s test bases. Saves trips, phone calls.

Miniaturized TV camera (left) developed by RCA, Princeton, N.J., for Air Force. Equipped with completely integrated, solid-state sensor for reliability.

Palantype shorthand machine (below left) adapted for computer input for immediate computer transcription. National Physical Labs, Teddington, Middlesex, Eng.

Live X rays on TV tube (below) allow instant examination of objects such as small electrical components for defects. Bell Labs, Murray Hill, N.J.

Crown Photo

Propellor for deep-diving submersibles allows helicopter-like maneuverability. Called Varivec (Variable thrust vector). Westinghouse Research, Annapolis, Md.

Heat pipe promises lightweight solution to high space temperatures. It transfers heat within spacecraft or dumps it overboard. Lockheed Missiles, Sunnyvale, Calif.

Battery which uses iron electrode, oxygen in air, produces more electric energy than conventional lead-acid car battery. General Telephone & Electronics, N.Y., N.Y.

SNAP-8 converts nuclear power into electricity. Conversion system intended as a power source in space. Developed at Aerojet Corp., Azusa, Calif., for NASA.

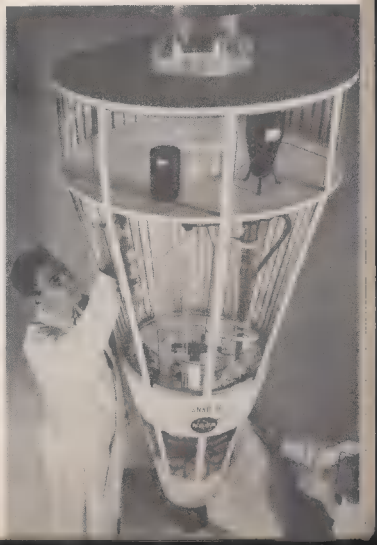


Photo: New Brunswick Travel Bureau

Tidal Bore rushes up the Petitcodiac River, New Brunswick, Canada. Front of wave is about two feet high, but many are often larger and very dangerous to swimmers.

The Racing Tides

Tidal bores with waves as high as 30 feet advance up river inlets carrying potential disaster to those ignorant of their approach. Fortunately, most bores are quite predictable.

by Jeanne G. Hawkins

WE READ OFTEN about "tidal waves" which have struck seashore areas and have caused great destruction. This was the term applied to the great wave which struck Alaska and the California coast several years ago after the Good Friday earthquake and brought added devastation. However, these waves are not tidal waves

and actually have nothing to do with tides. They are caused by upheavals and disturbances quite different from those that cause tidal waves. Actual tidal waves do occur, however. They occur in places like the Bay of Fundy, Cook Inlet, at the mouths of the Hwang Ho and the Severn and the Amazon Rivers. Instead of being called tidal waves, they are called "tidal bores" or "eagres." Very definitely linked to tidal action, they occur with the spring tides which is about every two weeks (sometimes called in-phase tides). For the most part, they are predictable, that is, it is known when they are to arrive. Even so, they can be dangerous and destructive.

On Nov. 18, 1922, a 2,000-ton ship, the *Topolobampo*, was enroute from Guaymas through the Gulf of California to the Imperial Valley. There were 125 people aboard, mostly agricultural workers and their families headed for work in the fields of California. The ship went aground on the mud flats near La Bomba. An anchor was paid out, and most of the passengers retired for the night feeling secure.

Then the tide turned. The Colorado Bore, where the river meets the Gulf, is one of the largest bores in the world. There is a variation of as much as 31 feet between high and low tides, and the single gigantic wave can ascend the river for miles. This time it came so suddenly that there was no time to warn the sleeping passengers, many of whom were drowned in their bunks as the boat rolled over and the passageways filled with water. The wall of water was 20 feet high and it appeared with the sound of a train, sweeping many overboard to drown in the violent aftermath of the wave. Some were carried, screaming and terrified, far upstream by the wave. Eighty-six people were drowned and, days later, others were found crawling on the mud flats, nude, half insane from thirst, sunburnt and covered with insect bites. One of these derelicts was Afrido Librean, the owner of the ship.

'A raging sea'

In 1539, Francisco de Ulloa, the first white man to sight the Colorado, was caught in the tide and stranded on the red mud flats. He reported the "sea to run with so great a rage into the land that it was a thing to be marvelled at and with like fury it turned again with the ebb." The following year Hernando d'Alarcon encountered the bore and reported that the "channel was filled with racing tides that almost drove the caravels ashore." The completion of the Boulder Dam in 1936 lessened this bore. Others can be controlled by river improvement or shifting sands. Some lesser bores eliminate themselves in time through erosion.

A bore exists only under specific conditions. The range of the tides must be considerable for a bore to occur. There must be either an obstructing sand bar at the entrance to the estuary or a sudden narrow-

ing of the river profile. These things can cause the incoming water to pile up until it spills into the estuary in the form of a fast moving wall of water.

There are innumerable estuaries opening into tidal seas, but only a few of these have spectacular bores. When Vancouver surveyed Cook Inlet, Alaska, in 1795, he had to work his ship up the inlet. It was tedious and dangerous work. The bottom of the inlet was covered with boulders and the water was shallow. The inlet was filled with chunks of ice that were carried back and forth by the strong tides. The range of tides here is up to 33 feet and the ship was able to move only with the onrushing bore. Cook Inlet is long, narrow and crooked, and the tide goes out almost as fast as it goes in. The inlet extends 200 miles inland, and some skippers claim the tide keeps getting worse instead of better as you go in. The incoming tide hits the beach at the upper end of the inlet with a four-foot wave, sometimes one wave on top of another. Bores here can be as high as ten feet and can be increased by wind and weather conditions which may add force to them. The instantaneous reversal of current which occurs with a bore and the sudden rise of the water bring turbulent conditions.

The Bay of Fundy, New Brunswick, has tremendous tides which in one place rise to 70 feet. The bore itself ranges from 30 to 50 feet. At Moncton, up the Petitcodiac River which empties into the Bay of Fundy, the bore is a tourist attraction and time schedules are posted for the convenience of visitors. In the area of Fundy a table of tides and currents is a necessity. Swimming is extremely dangerous without knowledge of tides and currents. The bores have been known to "overtake and swallow deer, swine and other wildbeasts as they feed on the shore." The swine, which feed on mussels at low tide are said to have developed a sixth sense about bores. Some say they snuff the bore either by sound or smell and dash to the cliffs before it rolls in. Every day four billion tons of water pour into Passamoquoddy Bay, and the Bay of Fundy receives about two hundred billion tons a day, so the bores are spectacular.

Harnessing the tides

Locks can be built to cope with these tides, to harness them and utilize all the power they produce. The Passamoquoddy Tidal Power Project on the border between Maine and New Brunswick will do just that. One is also being built on the Rance River in France, the first of its kind in the world, and one on the Severn in England. The Rance River project will produce 544 million kilowatt hours per year. The turbines not only will turn when the tide comes in but also when it rushes out. Tides here average 28 feet.

The rate of speed attained by these bores is great: In Pentland Firth, Scotland, there are bores which travel nine miles per hour.

Since the sun and moon control the tides, tidal power plants would be using cosmic power.

China's Hwang-Ho bore (called the backward flowing river because of the bores) often travels as fast as 25 miles per hour. The Amazon, that spectacular river which early explorers believed overcame the sea, has bores which travel in excess of 40 miles per hour. The tidal bore of the Amazon is another where there are two or three waves in succession about 12 to 15 feet high. Here they are called "pororcas." They scour the banks, gouge out the timberlands and make even wider the broadest estuary in the world. Sometimes the bore is evident 600 miles inland.

In 1542 when Francisco Orellano and his men travelled down the Amazon, they noted the rise and fall of the tides. This first awareness of tides was where the River Tapajoz enters the Amazon (about three hundred miles from the Amazon's mouth). When they arrived at the mouth of this giant river, they had long and dangerous tussles with the tidal bores.

The Tsein-Tang bore also reaches heights of 15 feet, but other well-known bores are smaller. The bore on the Severn is only about six feet high as it is on the Seine. Nennius wrote in his *Wonders of the Islands of Britain*, which he compiled about A.D. 820, "When the sea overflows, with the tide at the mouth of the Severn, two separate heaps of froth are formed, which strike against each other, and they attack each other by turns. They then recede the one from the other and again proceed, and this on the surface of the sea during every tide. This they have done from the beginning of the world to the present day."

The Hooghly, one of the channels by which the Ganges River of India empties into the Bay of Bengal, has a seven-foot bore which rises during the monsoon season. When Alexander the Great was at the mouth of the Indus in 327 B.C., his Greeks were terrified by the bores which wrecked many galleys and stranded others, nearly defeating an army that had been invincible on the battlefield.

Harnessed, these bores can provide tremendous power. It wouldn't be the first time the tidal motion was harnessed; tides were used for grist mills hundreds of years ago. Since tidal motion is caused by the motion of the sun and moon, tidal power plants will actually be harnessing *cosmic* power. Power is needed in such places as India where the Brahmaputra bore runs, or in Brazil where the Tocantins River swells with the bore from the Amazon. An ancient Chinese once said, "Water is the blood of the earth and the tides are the beating of its pulse." Utilization of tides and tidal bores seems only natural from that viewpoint.

MEDICINE

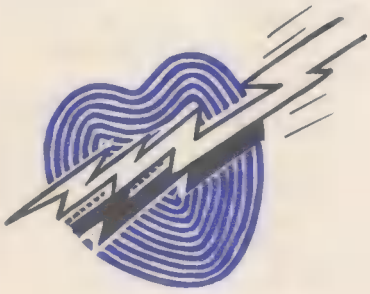
Lightning victims—back from the dead

by Arthur J. Snider

IT IS NOT given to many to take a trip to heaven—and return. Many victims of lightning could make the two-way journey if someone had the presence of mind to apply artificial respiration as soon as possible.

Doctors are becoming increasingly impressed by the potential for reviving those clinically dead, as determined by breathing, heart and brain wave action.

One of the most dramatic cases is



reported by Dr. Mark Ravitch, professor and head of pediatric surgery, University of Chicago medical school. A 10-year-old Baltimore boy, struck by lightning while riding a bicycle, was brought to the hospital 45 minutes later with heart at standstill, no pulse, lips blue and pupils dilated. When the chest was opened to massage the motionless heart, there was no bleeding. Metabolism had ceased.

"He was dead," commented Dr. Ravitch.

Five minutes later, the heart was restarted. The boy remained unconscious for almost six days but left the hospital after 29 days, fully recovered except for nasal speech.

"He was saved because a Boy Scout had rushed over and performed artificial respiration," Dr. Ravitch says. "When he was put into an ambulance, the adults did nothing for him. That's when he died. But the heart retained potential for viability because of the previous resuscitation effort. We know from transplantation surgery you can stop the heart, take it out and it will start up again."

Dr. Helen Taussig, the famed pediatrician who helped pioneer the "blue baby" operation, became interested in resuscitation from lightning stroke when a 10-year-old neighbor was hit on a golf course.

After reviewing the medical literature, she commented: "Alas, how few of the reports give any indication that any effort was made to revive persons who were reported instantly killed.

"The immediate treatment for anyone 'killed' by lightning should be directed toward restoration of heart action and respiration. The aid of a respirator may be required

for days or weeks. Frequently the patient regains consciousness and loses it again before he finally recovers."

Both Dr. Ravitch and Dr. Taussig point out that shock from lightning is less likely to be lethal than shock from electric current. Lightning usually produces a heart arrested with a normal sinus rhythm when the heart starts up again. A hot wire often produces cardiac arrythmia, the type of heart irregularity that afflicted Gen. Eisenhower during his latest heart attack.

Doctors at the outset sought to correct the former President's heart rhythm with a shock device, whose action is similar to a miniature stroke of lightning. They hoped to stop the heart and then obtain a normal rhythm on restarting it.

Dr. Taussig has this advice for people who may be exposed to a severe thunderstorm: "Respect it. Don't take refuge under a tree. Cast aside your fishing rod, your golf clubs, even your umbrella. Don't run, don't telephone and don't go swimming. Lie flat on the ground but away from trees and pools.

"Most important, if you are with a person who has been struck, remember that those who are stunned but alive are not the ones who most urgently need help. Such persons probably soon recover. It is the man who is 'dead,' with no heart action and no respiratory movements who needs cardiopulmonary resuscitation. When the heart starts, continue artificial respiration until you can get the man to the nearest hospital."

Dr. Thomas H. Coleman, a Carbondale, Pa., physician who lost a son to lightning stroke, says: "A valuable aid in estimating the electromagnetic field present in the atmosphere before the lightning discharge is to turn on a radio, tune in a local station and turn the volume down. The presence of heavy static indicates excessive electrical activity in the area. On the day my son was killed, I could not listen to the car radio or the radio in our home because of static. This situation existed for several hours prior to the fatal bolt."

Hypertension surgery

A nerve-cutting operation to relieve high blood pressure, popular in the 1930s but reduced to obscurity with the advent of new drugs about 15 years ago, has been revived in treating a group of patients with far advanced hypertension who had not responded to the drugs.

Dr. William W. Pfaff of the University of Florida said 12 patients have had the operation, and all but one showed significant decline in blood pressure.

"It should be emphasized that the operation is not curative," said Dr. Pfaff. "None of our patients have maintained normal blood pressures without the aid of anti-hypertensive medications. However, these medications are used in very small

amounts. In these reduced quantities, they avoid the side effects that limited pre-operative management. It should also be emphasized that we have used this operation only in individuals with the most severe form of hypertension."

The nerve-cutting operation was developed by Dr. Reginald Smithwick of Boston. It involved cutting the nerve branches that supplied the muscular elements of arterial blood vessels. The operation increased the diameter of the blood vessels and allowed more blood flow at lower pressure.

Sickening noise

Your job can make you sick, a study at Wayne State University shows. In a survey of 1,147 Detroit households, 15 percent reported

they were frequently exposed to abnormally large amounts of noise on the job. Two-thirds of these suffered from colds, influenza and infections at about twice the rate of those not exposed to excessive noise. Women did not have as much illness, indicating women react to noise differently than men.

Nutrition by vein

Weight can be gained and growth achieved when nutrients are provided through the vein for prolonged periods, it has been shown at the University of Pennsylvania. More than 200 patients with chronic complicated gastrointestinal diseases have been fed entirely by vein for 15 to 300 days. Ten infants have been maintained entirely by intravenous feeding for up to a year. Normal growth, development and activity have been documented by serial measurements, metabolic studies and photographs.

Dr. Stanley J. Dudrick, assistant professor of surgery, said it was the first demonstration that nutrients can be given exclusively by vein to support normal growth and development over a long period of time.

The average hospital patient who receives nutrition by vein generally is given 2,500 milliliters a day of a fluid containing five percent glucose. This supplies about 500 calories. However, the requirements of a resting adult are about three times this amount. If caloric needs are increased by fever, infection, trauma or a disease process requiring repair, the patient supported by the usual intravenous ration is forced to subsist on a starvation diet.

A food concentrate developed for

astronauts in space also has been found useful in the medical clinic for patients requiring nutritional treatment of disease states.

Dr. Robert V. Stephens of Rhode Island Hospital, Providence, told of the case of a 62-year-old man who was left with only two inches of small intestine and a half of his large bowel following surgery. The loss usually results in massive diarrhea, weight drop, malnutrition and eventual death. This patient had so much loss he could not even absorb blenderized baby food.

With the use of the astronaut diet, he was able to absorb increasing amounts of sugars and protein which were fortified with minerals, vitamins and essential fatty acids. One cubic yard of the solution would supply 3,000 daily calories for a month.

Teeth transplanted

Dentists at the University of Michigan have successfully transplanted two teeth from a 16-year-old girl to her brother, 13. Dr. James R. Hayward, professor of oral surgery, said it may be the first instance in which transplanted teeth survived with a living pulp.

The bicuspids of Mary Batten of Elkhart, Ind., had to be removed because they were wedged between the jawbone and other teeth. By chance, the bicuspids of her brother Bill had never developed.

The transplant was performed in February 1968. X rays now show that a new layer of dentin is being formed inside the pulp canal and new sockets have developed in the jaw. Tests show that the nerve supply is migrating into the new teeth.

Previous efforts to transplant teeth between individuals have resulted either in a failure to "take" or the teeth succumbed to the recipient's natural defenses, which resorb the bone. Transplantation of teeth from one part of the mouth to another part in the same patient has been successful, but never between two individuals.

Why this transplant has worked remains a mystery. Even their blood types differ.

"If we can determine why the transplant worked for the Battens," says Dr. Hayward, "then other transplants between different individuals may be planned with greater hope for success."

The transplant was done with the patients in adjoining rooms. For six weeks, the teeth were held in place with stabilizing wire. It was not until the end of September that

X rays showed for the first time the roots of Bill's new teeth had started growing.

Blood diseases and pets

Six cases in which patients and their pets have come down with leukemia or other blood-linked malignancies are reported in the "Journal of the American Medical Assoc." (See "Zoonoses," Sci. Dig. Dec. '68.) All involved dogs or cats.

Dr. Michael V. Viola of Sloan-Kettering Memorial Hospital, New York, said he doesn't know whether the relationship is more than a coincidence. "It would be hard to prove that the co-occurrences in patients and pets is not a chance factor," he says, "because these cancers are frequent in animals."

There is only one previous report of this type in the literature. Two years ago a doctor described the occurrence of lymphoma, a cancer of the lymph glands, in both a boy and his pet.

In the first case collected by Dr. Viola, a 47-year-old man was admitted to the hospital because of persistent pain in the lower back. Biopsy showed a cancer. He was treated with radiation and drugs but died eight months later. Two months after that, the patient's mixed-breed, six-year-old cat died. An autopsy showed the same lymph node enlargement in the abdomen.

A boxer died of lymphoma a year after its eight-year-old master died of a leukemia involving the lymph glands. Other associations involved a 60-year-old woman and a Doberman pinscher, a 13-year-old boy and a mixed-breed pup, a 54-year-old man and a Basset dog.

In all but one case, clinical recognition of the animal's disease followed the owner's disease by months to years.

No virus particles could be found in the two animals whose tissues were studied with an electron microscope. Dr. Viola, a researcher in the field of viruses and cancer, says that while cancer-causing viruses have been demonstrated in mice and some other lower animals, none has been found in human beings.

Nighttime allergies

Allergy must be suspect if a child seems well by day but coughs through the night, says Dr. Lewis A. Barnes of the University of Pennsylvania. He advises the mother to vacuum the room thoroughly each day for dust, temporarily remove all toys and substitute sheets and blankets made of different material.

Sleeping position may even be a factor. During the day, sinus drainage can run out of the nose and postnasal drip secretions are coughed out more easily. At night these secretions may well irritate the posterior pharynx. If a medical examination rules out infection or other disorders, a vaporizer to increase room humidity may be helpful, the physician says.

CAT means bad luck to pilots

PILOTS DREAD a CAT (the upper-air kind) because they can't see it. Clear Air Turbulence, typified by wind sheer forces at the edge of the jet stream, for instance, is not betrayed by thunder or clouds. It has caused crashes.

Robert W. Astheimer, vice-president of Barnes Engineering Co., Stamford, Conn., was recently granted a patent for a method of spotting the invisible disturbance a considerable distance ahead. The pilot can avoid it, or at least slow down, greatly reducing the danger.

A marked rise in temperature gives CAT away. The pilot now scans ahead at various levels with a radiometer to detect infrared radiation from carbon dioxide, uniformly distributed through the air.

The infrared wavelength at which peak radiation is registered indicates the distance, and this is displayed on an instrument.

In Patent 3,402,295, which he assigned to the company, Astheimer explains that there is invisible high turbulence at one edge of the jet stream. High-flying airplanes bound from west to east use the jet stream to save fuel, and need CAT warning.

Equipment recently developed by Barnes Engineering for CAT detection is beginning to undergo extensive tests. Pan American Airways is installing it aboard a Boeing 707-100B; Eastern Airlines and Trans World Airlines will also mount the equipment.

Tests with an earlier Barnes infrared spectrometer were conducted for the Federal Aviation Agency by the national aeronautical establishment of the National Research Council of Canada. The instrument was mounted in a pod under the fuselage of a Canadian T-33 aircraft (see picture above) and flown in Canada and California.

FAA said the device showed promise and commented that, with more refinement of the spectrometer, jet pilots might be able to detect turbulence from a distance of 30 to 50 miles. The new tests are being undertaken in the hope that this can be attained. —*Stacy V. Jones*

PHYSIOLOGY

Hiccups—the good-for-nothing reflex

EVERYBODY GETS HICCUPS—even pontiffs and pundits. There are the garden variety, which last only a few minutes and usually stop of their own accord or with the aid of one of several hundred inventive home remedies. And there are hiccups of the more redoubtable kind, which hang on for hours, sometimes for months and—according to a few case histories—for years.

However long they last, hiccups are simply a body reflex, but a good-for-nothing one. Coughing, sneezing and vomiting, which are also spontaneous reflexes, serve a purpose; they clear clogged air passages or expel toxic substances. But hiccups don't have a protective function—they just annoy.

Most people think hiccuping is funny. In the early days of movies, hiccuping was a cliché used to show drunkenness; it invariably provoked gales of laughter. But Jack O'Leary of Los Angeles found no humor in his attack. He "hicked" more than 160 million times in a bout that lasted eight years—from 1948 to 1956. During that time his weight dropped from 138 to 74 pounds. A sympathetic (and often sadistic) public sent him over 60,000 suggestions for stopping his hiccups. O'Leary insists that the one that worked was a prayer to St. Jude, patron saint of lost causes.

Although most cases are mild and don't last as long as O'Leary's did, hiccups can be a serious problem.

Drawings by Lou Myers

Drs. Charles E. Friedgood and Charles B. Ripstein warned in *The Journal of the American Medical Association:* "Hiccups may be a minor symptom of transient duration or may progress to exhaust the patient's strength and produce marked depression or even death."

Physicians are likely to have as many ideas about how to treat hiccups as laymen have. Treatment depends upon the duration of the hiccups, the events surrounding them, the patient's medical history and a number of other things.

According to a 10-year survey of hiccups prepared by Dr. Lester Samuels of Kew Gardens, New York, there are at least 33 physiological and 10 psychological bases for prolonged hiccups. Dr. Samuels said that mental and emotional disturbances are responsible for the

majority of cases seen by doctors. He lists the prevalent causes as: mental shock, prolonged mental strain, drug addiction, malingering, postpartum depression, cardiospasm and publicity seeking.

The anatomy of the hiccup is pretty complicated. Three main parts get into the act: the glottis, the phrenic nerves and the diaphragm.

The chief troublemakers in hiccuper harrassment are the phrenic nerves, a string-sized bundle of fibers attached to the spinal cord. The right phrenic nerve controls the right half of the diaphragm and the left phrenic nerve controls the left half.

Normally, in signaling the diaphragm to contract on schedule, the phrenic nerves act in harmony. But sometimes a message carried from one of the abdominal organs (an overloaded stomach, for example) by way of sensory nerves to the brain causes a disruptive reflex action in the phrenic nerves and interrupts the rhythm. This in turn causes the diaphragm, which is the body's primary breathing muscle, to go berserk.

The disrupted diaphragm contracts in a series of spasms and the victim inhales with each contraction. This is where the "hic" comes in. (Or perhaps we should say "out.")

The short, sharp, indrawn cough of hiccups is the sound of the glottis snapping shut. The glottis, at the base of the tongue, is the structure surrounding and including the vocal cords. It snaps closed across the throat as the diaphragm bows downward and breath is sucked in. The hic is an unsuccessful act of inhalation.

All in all, the glottis is a noisy thing. When we have a cold, it makes the "cough" sound by abruptly opening. Not surprisingly, this noisemaker has claimed the attention of the poet as well as the doctor. In a short poem called "Can I Get You a Glass of Water? or Please Close the Glottis After You," Ogden Nash celebrates the noisemaker,

> . . . Glottis—schmottis!
> Not that I reject the glottis theory, indeed I pride myself on the artistry of my glottistry. . . .*

The artistry of the "hicking" glottis can be set off in many ways;

*© By Ogden Nash, 1953. First published in The New Yorker.

gulping hot or cold liquids, overeating or overdrinking, too much smoking, fatigue or even hearty laughter after a big meal. One man insists he gets hiccups every time he gets near the meat counter at his local supermarket.

Ordinarily, hiccups are not a medical problem. They usually taper off and go away without too much trouble; all that's needed is something to interrupt the spasms and the diaphragm's normal rhythm will be restored. Hiccups persist because the diaphragm picks up a rhythmic cycle of spasms. In a normal cycle, the spasms occur anywhere from every 15 seconds to every three or four minutes. In more serious cases, hiccuping may range from 100 to 300 spasms per minute.

Sometimes hiccups stay and stay, often for weeks and months. One man started hiccuping when his appendix burst and he continued to hic for 10 years, except for a few brief respites. In January, 1954, Pope Pius XII had an attack of gastritis accompanied by hiccups that lasted for days. Months later, *The New York Times* reported a recurrence and said the hiccups were "the first warning of the grave malady that struck him shortly early this year." Four years later, a few months before his death from a stroke, it was reported again that the Pope was "stricken with gastritis accompanied by prolonged hiccups."

Often, hiccups are the result of a postoperative condition—perhaps a complication of chest or pelvic surgery. Chronic hiccups can come from gastric irritation, ballooning of the stomach, calcium deficiency, gout, uremia, malaria, meningitis and encephalitis. Other causes are tumors, hemorrhages, brain injury, ulcers, abcesses, aneurysm and pneumonia.

It's often hard to diagnose the precise cause of hiccups. Once, in the ward of a Minnesota hospital, 17 patients began hiccuping at about the same time. At first the doctors thought they just had a hiccuping epidemic on their hands; closer examination showed that all the hiccupers had streptococcus infections. When the infections cleared up, the hiccups stopped.

Almost 300 recorded cures for hiccups have been developed over the centuries. Many of the folk remedies shock the scientific mind, but more often than not the end justifies the means. Except, perhaps, those that seem to have been created in Dr. Frankenstein's laboratory: hang the hiccuper by his ankles, or have him munch a wax candle or chug-a-lug a jigger of vinegar until he stops. Plato recommended a surprise thump on the

back, and his contemporary, the dramatist Aristophanes, said his physician suggested tickling the nostril with a feather.

Most home remedies work on the principle of creating a counterirritant to shock the phrenic nerve back into normal behavior. Shouting "boo" might do the trick, but breathing in and out of a paper (not plastic) bag has just as good a chance of succeeding. The paper bag trick is believed to be the first hiccup cure to appear in print; it was listed in an apothecary's dictionary back in 1580.

One remedy considered surefire by a number of people is the ear and water cure. You'll need help with this one. First, press the tab of flesh in front of the opening to the canal of each ear with your fingers to make certain no air gets in. Next, tilt your head back slightly while someone feeds you a glass of water. Often, more than one glass may be needed but this method usually takes care of the garden variety of hiccups.

The ingenuity of the folk healers is never dampened. Swallow bread or crushed ice, some say. Place cold applications on the spine or warm ones on the diaphragm. And so it goes.

Some of the medical cures are also tough to take. For instance, to protect a hiccuping patient against enlargement and irritation of the diaphragm, the doctor empties the stomach by inducing vomiting. In very severe and long-lasting cases of hiccups, it may be necessary to freeze, crush or sever the left or right phrenic nerve. This is done to interrupt the impulses to the diaphragm.

Crushing the phrenic nerve failed in the case of one man who had been hiccuping intermittenly every day for nine months. In addition to the nerve crush, the man was given every known therapy—including psychiatric treatment—but nothing worked. Finally, after five days of intensified hiccuping, the exhausted man was brought to the hospital and given chlorpromazine, a tranquilizer. His hiccuping stopped.

Other medical cures include sedatives or anesthetics, which put the patient to sleep and interrupt the spasm rhythms. Some doctors have reported success with hypnosis. (An executive of a large corporation says he stops his fits of hiccuping with *self*-hypnosis.)

Using both medical and folk remedies, we have many ways to defeat the hiccups. Fortunately, since the odds are a million to one that hiccups will disappear within a few minutes, it seems that the best advice to give a hiccuper is: Relax and don't get your phrenic in a frenzy.

Remains of famous King Croesus' gold workshop, as well as bits of refined gold, have been discovered at Sardis, Turkey, by a group of Harvard-Cornell archaeologists.

Rich Croesus' secrets

THE SAYING "as rich as Croesus" took on new meaning recently when *Harvard University* announced that the remains of the Lydian king's gold workshop had been dug up at Sardis, Turkey. The bits of refined gold and fragments of gold-working apparatus attest to the fabled wealth of Croesus, who ruled Lydia in the sixth century B.C.

The apparatus used in the workshop includes crucibles, blowpipes and over 300 "cupels," small clay-lined depressions in the ground in which gold was refined from lead ores by flames directed by the blowpipes. Small furnaces found were probably used to separate the silver from the gold. The site is near the Pactolus torrent, a river which the historian Herodotus tells us was famous in antiquity for its gold-bearing sands.

Some of the *refined* gold, however, seems to contain small quantities of silver, which makes archaeologists wonder if Croesus craftily debased Lydia's coinage. The probable explanation for the practice, they think, is that Croesus' output of pure gold was limited because of his primitive refining techniques and some silver had to be used.

The refining technique probably involved two main steps, according to Sidney M. Goldstein of Harvard. First impure gold, mixed with lead in a five-to-one ratio, was placed in the cupels under a heap of charcoal. When blowpipes had blown the charcoal flames to the desired heat, the lead drew out the base metals in the gold. The lead itself was ab-

sorbed by the ash coating the cupels.

The button of pure "electrum," a pale-yellow alloy of gold and silver, left by this process was pounded into leaves. The leaves went into the furnaces, which were lined with salt and powdered brick. When the furnaces were heated to about 1,300° F., the salt dissolved out the silver and formed a silver nitrate that was absorbed by the brick powder.

The discovery of Croesus' gold workshop is the latest in a series of finds that have been made at Sardis in the 11 years since Harvard and *Cornell University* undertook a joint expedition to the site of what was at one point in history one of the major cities of the world.

One of the finds is the synagogue of Roman Sardis, by far the largest known from classical antiquity. Inside it, workers discovered a relief sculpture of two goddesses, Artemis and Cybele, accompanied by two worshippers. South of the synagogue is a Byzantine shopping center where a series of fifth and sixth century shops have been uncovered.

Probably the most impressive building unearthed at Sardis is the Roman city gymnasium. Its 60-foot high entrance court, which architects call one of the most important examples of Roman architecture in the eastern Mediterrean region, is being restored, complete with pavilions and main gate.

It moves! It glows! It's art!

A curious ceremony took place one evening late last spring on the shores of Lake Michigan at Evanston, Ill. Garbed in flowing white robes, students of *Northwestern University* sat in a circle lit by red flares and watched other students purify water from the polluted lake in a small distillation unit. Glasses of the purified water were handed around afterwards. A few members of the audiences refused to drink it.

"Spectacularly beautiful!" cried Jack Burnham, assistant professor of art at Northwestern, whose students were performing the rite as the final project in Burnham's novel "Art and Systems Analysis" course. Engineering students enrolled in the class designed the purifier (with the help of a glassblower from the chemistry laboratory) and arts-minded students created costumes and liturgy for the event.

The purification ceremony is one of the more spectacular of Burnham's efforts to bring about a mutual understanding between engineers and artists, a meeting of minds he thinks vital to "man's happiness and survival in a world governed by technology." He has published a book on the effects of science and technology on modern sculpture and he has one coming up entitled *Systems and Art*.

Just what is the systems approach to art, which Burnham thinks will make man again able to involve

himself sensually with daily life? In his Northwestern course, Burnham asked his students to analyze in detail or to devise any of a number of systems ranging from Northwestern's parking lots to a bodily function. One student came up with a "happening" in which a movie projector showed a recorder recording while in another part of the room a recorder played a recording of a movie projector projecting.

In his own work, Burnham uses technological methods to achieve what he calls "kinetic sculpture."

No one except Burnham seems quite sure if his work is art, technology or (as he hopes) a mixture of both, but there are signs that the scientific world is beginning to appreciate his efforts. Massachusetts Institute of Technology has awarded him a one-year fellowship which will last through this school year.

Northwestern students (above) look at a "viewer-activated luminous ribbon" sculpture by kinetic sculptor-professor Jack Burnham (below) who is concerned with the effects of technology and science on art.

Cavity-causing toothpaste

Some brands of toothpaste may give you cavities, according to two members of *Indiana University's Department of Preventive Dentistry*. They tested 43 dentifrices and found that some new "whiteners" are twice as abrasive to dentin as regular toothpastes. Dentin is the bony structure normally protected by tooth enamel or gums. After many brushings, says the Indiana team, the whiteners groove the teeth, making them more susceptible to cavities.

Each month Dr. Isaac Asimov chooses one of the questions you send in to answer. He does not make the job easy on himself, for in past months he has written about such things as relativity, parity and the basic nature of light. Following Dr. Asimov's answer are the answers to some of your other questions written by regular members of the Science Digest staff.

Biological clocks

Just what is meant by "biological clocks," and how do they work?

Sometimes you don't have to look at a clock. When you get hungry, you know it's dinnertime. When you get sleepy, you know it's bedtime. If you have had a huge lunch, of course, you may go well past dinnertime before getting hungry. If you have slept late or are at an exciting party, you may go well past bedtime before getting sleepy. Under ordinary conditions, though, you can come pretty close.

There is a cyclic change inside you that makes you feel hungry every so often and sleepy every so often. These changes are quite regular so that you can measure time (rather roughly) by these cycles. Such cycles are an example of "biological clocks."

There are steady cycles in the world outside the organism. The most noticeable one is the alternation between the light of day and the darkness of night, but there is also the twice daily rhythm of the tides which varies in amplitude with the monthly phase-change of the moon, and there is the temperature cycle that varies with the day-night period and with the annual period of the seasons.

It is useful for an organism to respond to these changes. If its food is to be found by night or only in the warm season, it might as well sleep during the day or hibernate during the winter. If it is going to lay its eggs on the shore it can do it best at the highest high-tide that comes with the full moon. Even plants respond to these rhythms so that leaves curl at sunset, flowers or fruits come at particular seasons and so on.

We can't suppose that living or-

ganisms do all this consciously. They don't say "It's nighttime, I shall sleep," or "The days are growing shorter, I shall drop my leaves." There are, rather, automatic cycles within the organism that match the astronomic cycles in the world outside. This match is produced by natural selection. Animals or plants that possess a good match do better and have a chance at more offspring than is true of those with a poor match, so that generation after generation the matches improve.

The inner cycles exist even on the molecular level. Body temperature shifts up and down regularly, so do the concentration of certain constituents of the blood, the susceptibility of the body to certain drugs and so on. Most of these cycles take about a day for the completion of one up-and-down movement, and these are called "circadian rhythms" from a Latin word meaning "about a day."

Is the inner cycle controlled by the environmental rhythms? Not entirely. If an animal or plant is placed in an artificial environment in which the outside rhythm is removed—where there is constant light or constant temperature—the rhythms go on anyway. They may be less marked and may vary somewhat from a strict 24-hour cycle, but they are there. The environmental rhythms act as no more than a "fine control."

Men and women who jet across great distances find themselves in a radically different time zone, and their internal rhythms no longer match the day-night period. This gives rise to many uncomfortable symptoms until the biological clock is reset.

As to how the biological clock works. I can tell you in two words. *Nobody knows!*

Is it some sort of periodic chemical reaction in the body? If so, the clock should vary with temperature or with drugs, and it doesn't. Is it something that is keyed to very subtle rhythms in the outer world that persist even when we wipe out light and temperature variations? Maybe, but if so, we have not yet discovered the nature of those rhythms.

—Isaac Asimov

It seems like people are always taking miracle drugs called antibiotics. We all swear by them, but exactly what are they?

Antibiosis — "antagonistic association between organisms to the detriment of one of them," according to Webster—has more or less always been an easy condition to promote. That is, there is a long list of organic poisons that kill germs effectively. Unfortunately, the poisons also kill, or make seriously ill, the person infected by the germs.

The trick (or miracle) was to find a substance that destroys germs—

anti (against) biotic (life)— without destroying the patient. Living tissue has the ability to absorb selectively certain substances. For example, bacteria are sensitive to certain dyes—some are absorbed; some are rejected. Realizing this, German chemists discovered in 1935 that a red dye containing the substance "prontosil" was remarkably anti-bacterial. Also, it seemed to cause no ill effects in patients.

Streptococci bacteria (responsible for scarlet fever and erysipelas) seemed particularly vulnerable to the dye which was obtained from, among other things, sulphanilamide. From this basic discovery later evolved the modern sulpha drugs, antibiotics in general use today against many diseases.

Penicillin, produced by a submicroscopic mold, is probably the best known of the antibiotic drugs. It was first discovered in the late 1920s. Scientists noticed its antibacterial tendency, but at that time it did not occur to them that penicillin would attack only bacteria and leave other living cells unharmed. It was years later that the real breakthrough was made. Penicillin is now used in treatment of infections from pneumonia to skin diseases.

Doctors found out long ago that bacteria can become immune to antibiotics if the dosage is small enough or often enough. For this reason, your doctor probably does not prescribe antibiotics unless absolutely necessary.

Signs of aging

by John and Molly Daugherty

ALL OF US want to live a long time without growing old. But if you live long enough, you will be old someday. One thing alone, however, won't make you old. Many things will, for aging comes from multiple changes. What do you know about aging?

1. Research scientists using very young laboratory rats have increased the rats' average lifespan by applying just one technique. This is
   a. Injecting hormones
   b. Supplying supplemental vitamins
   c. Restricting food while the rats are very young

2. Your attitude toward life affects the rate of aging of your nervous system. If you're an extrovert, your nervous system deteriorates
   a. Faster than an introvert's
   b. More slowly than an introvert's
   c. The same as an introvert's

3. Grandma may grab her red coat and be out the door for a ride, a movie or a party before Grandpa puts down his newspaper and gets out of his armchair. The age at which both men and women change to become more alike in their patterns of response is
   a. Sixty to seventy
   b. Seventy to eighty
   c. Eighty to ninety

4. As you age, hearing loss of high frequency sounds normally occurs. By the time you are 40, the reduction is about 160 vibrations each year. Even so, at the same age
   a. Women hear an octave higher than men
   b. Men hear an octave higher than women
   c. Men and women hear high frequencies equally well

U.P.I.

By the time a person reaches age 102, like Mrs. Margaret Young of Detroit, she has every right to be graciously endowed with a very natural sign of aging—wrinkles.

5. The average old person begins not to care so much what goes on in the world (the "disengagement process" of aging) when he reaches
   a. Sixty-five
   b. Seventy-five
   c. Eighty-two

6. Loss of collagen from the skin occurs as you get older. Skin is
   a. Of equal thickness on men and women
   b. Thinner on men
   c. Thinner on women

7. You are apt to use the most sugar to sweeten your cereal if you are
   a. A young adult
   b. An elderly person
   c. A middle-aged person

8. **Older people's skin is less smooth than yours because**
   a. **It wears away**
   b. **Fatty deposits lump together close to the surface**
   c. **Fat within the skin shifts to deeper locations**

9. **Skin exposed to sunlight**
   a. **Tans, but the exposure does not affect the aging process**
   b. **Ages more than skin covered by clothing**
   c. **Undergoes an increase in the amount of collagen**

10. **Your handshake will grow weaker as you grow older. Between the ages of 35 and 80, the strength in your dominant hand will drop 50 percent. Your subordinate hand will be able to grasp**
   a. **Almost as well as your dominant hand**
   b. **Only a third as well as your dominant hand**
   c. **With more strength than your dominant hand**

Answers:

1—c Restricting food while the rats are very young. During early months of growth the nourishment of the rats was kept at a low caloric content. By the time the rats reached about two-thirds of their normal size, they had already outlived the usual life-span. Their overall life-span was nearly double. These laboratory rats were resistant to diseases that ordinarily would have killed them, and at all times they appeared younger than their chronological age.

A rat allowed to grow fat at any time ended up with a shortened life-span.

2—b More slowly than an introvert's. Data from recording brain waves of patients at a psychopathic hospital showed that voltage changes differed depending upon age and personality. Full development of the nervous system at about 20 years of age showed a gradual reduction of the voltage changes of the electroencephalograms. Extroverts matured much faster in nervous system control and maintained that control until they reached 59. But introverts showed some deterioration, indicated by increases in voltages, by the age of 39.

3—c Eighty to ninety. Then their patterns become remarkably alike in many ways—for instance, in dependency, self-satisfaction, serenity, etc.

Earlier, in their young old age, men are thoughtful and wise (though sometimes opinionated). They prefer their activity to be useful or educational. Women, in *their* young old age, however want to be "on the go" carefree enjoying their freedom—a counterbalance to their having been tied down so long to housework and children.

4—a Women hear an octave higher than men. Two factors contribute to a higher range for women. First women have thinner eardrums which respond better to the low energy in high-frequency tones. Second, the ear bones of women are lighter in weight and move with less applied energy.

5—b Seventy-five. His optimism and orientation toward the future starts to disappear then if he's like most old folks. Scores on measurement tests indicate that he'll conform less and feel less compulsion to do the expected thing after he reaches seventy-five.

6—c Thinner on women. A woman's skin contains less collagen than a man's. Collagen is a tough protein which is an important stiffening substance found in all connective tissue. Loss of collagen with increasing age leaves a woman's skin with less support than a man's.

7—b An elderly person. Many changes in your body occur so slowly you are hardly aware of them. A young child has taste buds all over his mouth but by the time he is ten years old, he loses the extra ones. As you get older your sense of taste diminishes. An elderly person may use three times as much sugar as a young adult to be able to taste the same degree of sweetness.

8—c Fat within the skin shifts to deeper locations. Frowning and making gestures that crinkle the skin cause the fat to move and deepen furrows.

9—b Ages more than skin covered by clothing. Research shows that skin exposed to sunlight wrinkles earlier. Arab dress with long robes is a perfect adaptation to the hot desert sun.

10—a Almost as well as your dominant hand. Your endurance in maintaining a firm grip diminishes only a third between 35 and 80, however.

Score yourself:

9—10 right—You must be an old hand!

4— 8 right—There are some wrinkles in your thinking.

0— 3 right—You must have aged over this one.

"Did you ever look at peanut butter and jelly under a microscope?"

BOOKS

Tales of the sea serpents

In the Wake of the Sea-Serpents. By Bernard Heuvelmans. Hill and Wang. ($10.00).

Over a decade ago Bernard Heuvelmans, a Belgian zoologist with a flair for the romantic and exotic side of his subject, wrote *On the Track of Unknown Animals,* a virtual encyclopedia of all the evidence, legends and rumors concerning large land animals, as yet unknown to science.

As a work of serious zoology the book was of dubious value. One might point out that in the last 10 years not a single one of the creatures that Heuvelmans wrote about has been found. But there could be no denying that *On the Track of Unknown Animals* made fascinating reading. This reviewer found himself wanting to agree with Heuvelmans even if the evidence seemed insufficient or downright foolish.

Now with *In the Wake of the Sea-Serpents,* Heuvelmans has done for unknown sea creatures what he previously did for unknown land animals. The new book is much better than the previous one, principally because the evidence for unknown sea creatures is better than for unknown land animals.

Now, how good is that evidence? Unfortunately, it is not nearly as good as Heuvelmans thinks it is. The weakest and most irritating parts of the book are those in which Heuvelmans insists that the weight of evidence supporting the existence of large unknown sea creatures is absolutely overwhelming, and that anyone who fails to agree is an idiot. He clearly feels on the defensive and spends a good deal of time denouncing most professional scientists as fools.

Heuvelmans announces that he will be, "quite merciless in sorting out the items in the dossier. Whenever there is the least chance of a mistake the report must be rejected." Fortunately he does not live up to these rigid standards. If he did the book would be far less interesting and ever so much shorter. Besides, how can one be sure that there is not "the least chance of a mistake," in a report that may be decades or even centuries old. Like most enthusiasts for the unknown, Heuvelmans seems unaware of the long history of human error and folly.

The real charm and interest of this book is in the enormous collection of sea serpent (or sea monster) stories. Of course, all the old familiar stories are there, but there are plenty that will be new, even to those who are familiar with the subject.

After collecting all the evidence, Heuvelmans then attempts to wrap up the sea serpent mystery by telling what animal or animals he thinks are responsible for all the stories. Amazingly enough, he believes that the whole sea serpent

legend was inspired by the sighting of large unknown—but no, that would be telling. It would spoil the reader's fun. Part of the charm of this book is following the author step-by-step as he builds his case. You may not agree with him—I certainly don't—but you cannot deny that his conclusions are original and impressive. And I'm sure that you will join me in hoping that he is right after all.—*Daniel Cohen*

Other new books of interest

Toward the Year 2018. Edited by the Foreign Policy Association. Thomas Y. Crowell Co. (5.95). Everyone loves to peer into the future, and occasionally a group of intelligent specialists will make educated guesses at what's to come. So herein lies what's to be expected 50 years hence.

Gene Control in the Living Cell. J.A.V. Butler. Basic Books. ($5.95). Those remarkable chemical units that control man's heredity have remained much of a mystery until recent years, and there still is a great deal unknown about them. But here is a thorough picture of what is known about the gene and its control of the cell. Half of the book deals with genes as related to cancer.

Life, Death and the Doctor. Louis Lasagna, MD. Alfred A. Knopf, Inc. ($6.95). A practicing physician and research scientist gives the medical profession and its key role in society a thorough examination. He covers everything from medical schools to air pollution and medical-legal problems, as well as the fundamental questions such as birth control, abortion and euthanasia. The reading's not at all dull.

Telescopes: How to Choose and Use Them. Terry Maloney. Sterling Publishing. ($3.95). Selecting the right telescope can be an important task for the amateur astronomer. Here's advice from an experienced man, a Fellow with the Royal Astronomical Society of England. It's well illustrated. (See "Build a 4¼-inch reflector lens telescope," November '68 *Science Digest*.)

Spare-Part Surgery. Donald Longmore. Doubleday. ($5.95). Man is now becoming used to the idea of replacing worn out kidneys with those of a close relative; even replacing hearts, once considered impossible, has become fairly common. And Dr. Longmore points out that with today's knowledge of genetics and tissue growth, there's no limit to the possibilities in the future.

Mallory of Everest. Showell Styles. Macmillan. ($4.95). Mount Everest has been conquered, so to speak, but George Leigh Mallory died still trying to reach the summit of the world's highest mountain. Here's

the exciting and tragic tale of Mallory's three attempts at the big one and why his name today is still so closely associated with Everest even though he failed.

Kinship and Social Organization. Edited by Paul Bohannan and John Middleton. Natural History Press. For the amateur or professional anthropologist this is a gem of a collection of articles dealing with the study of kinship and descent among ethnic groups throughout the world, with a special section on Australia—"the home of much of the theory about kinship and descent."

Winged Rocketry. Major James C. Sparks. USAF (Ret). Dodd, Mead. ($4.50). Here is a well-illustrated book tracing the history of rocket planes from the first crude varieties fired by coolies in ancient China to those used during World War II and on to future craft which may transport astronauts to and from orbit. It's well worth reading for the aviation enthusiast.

The Tides: Pulse of the Earth. Edward P. Clancy. Doubleday. ($4.95). The phenomenal rising and falling of the tides which never fails to occur has always intrigued man. Here is a graphic and thorough examination of this natural wonder which will answer many questions for those with particular interest, but it may prove somewhat technical for the average layman.

The Big Machine. Robert Jungk. Scribner's. ($6.95). The Big Machine happens to be the atom smasher at Meyrin, Switzerland, one postwar dream that has come true. The operation of the machine is so complex that one nation couldn't support it alone, so CERN (translated from French to mean European Organization for Nuclear Research) was established. It's a fascinating story of modern day science and scientists that will interest the layman as well as the expert.

Man and Heredity. G. W. Roderick. St. Martin's Press. ($7.00). A survey of the part genes play in heredity is aimed at those people who need a clear understanding of the subject but are not genetics experts. On the whole, the book is easy enough to understand for the intelligent layman, but there are a few technical parts. The discussion of particular inherited traits (such as hairy ear rims that are relatively common in men *only* in India) is quite interesting.

Courtship: An Ethological Study. Margaret Bastock. Aldine. ($6.00). Concentrating on examples among birds, fish and the higher invertebrates known as arthropods, the author, a zoologist, describes the curious ways in which these creatures meet and mate. Equal space is devoted to the evolution and mechanisms of courtship. Simply written, this small book is a good choice for the student and the nature lover.

1969 Britannica Yearbook of Science and the Future. Encyclopedia Britannica, Inc. ($8.95). Anyone interested in the scientific explosion that has occurred over the past several decades will find this 448-page volume good reference material. The future is not neglected either, and there are over 150 color illustrations.

The World of the Grizzly Bear. W. J. Schoonmaker. J. P. Lippincott Co. ($5.95). Here's a fine addition to an already fine "Living World" series. The author has captured the strength of this formidable mammal in both words and some excellent photographs. In spite of the immense size and power of this creature, it is another of Nature's animals that are rapidly approaching extinction.

Hummingbirds and Their Flowers. Karen A. Grant and Verne Grant. Columbia University Press. ($17.50). Aspects of hummingbird pollination are the center of focus here, and though amateur naturalists would probably find it interesting, it's not likely that anyone but a professional would care to spend this sum of money on a book on the subject. Excellent pictures.

When Nature Runs Wild. Thomas P. Johnson. Creative Education Press. Nature can be quite violent at times as earthquakes, volcanoes, floods and hurricanes frequently prove. Here's a very easy to read and understand look at those wild moments.

CLASSIFIED ADVERTISEMENTS

Rate: $5.00 for first 2 lines each insertion. $3.00 each additional line. Minimum space accepted is 2 lines, payable in advance. Count 45 characters and/or spaces per line. To be inserted under the proper classification, copy must be in our office by the 1st of the second month preceding date of issue. **The next available issue to place an advertisement in Science Digest is April, 1969. The closing date is February 3, 1969. Send remittance and order to: Hildegard Esposito, Classified Advertising Manager, Science Digest, 575 Lexington Avenue, New York, New York 10022. Please make remittance payable to Science Digest.**

SCIENCE AND CHEMISTRY

300 Page Chemical & Apparatus Catalog $3.00. Laboratory Materials, 1330A Hyde Park, Chicago 15.

VAST converging stellar energies hit atoms, push-in-then-out, and cause gravity. 1968 book $1.00. Carnahan, 2007 Eaton Lane, Austin, Texas 78723

LASER pistol, how to build—$1.00. Phaser pistol—you've seen it on TV, now build your own — safe loads of fun—$1.00. Build laser rifle, electronic laser, flying saucer—$4.95 each. Complete catalogue prize-winning science projects—35¢. Roy Davis Lab. 118 West Adams, Jacksonville, Fla. 32202.

SOLAR Flying Saucers (New—Sun Powered—no motors). How to build easily for less than $5 using Styrofoam and plastic bags. Many sizes-designs. Complete descriptions-plans-drawings. $1. Guaranteed. Spacetronics, Box 31043-D, San Francisco, Calif. 94131.

21st CENTURY SCIENCE PRODUCTS. Incredible science products of the future available now! Amazing catalog and gift—50¢. R. J. Graham, 171 East Bank, Fond du Lac, Wisconsin 54935.

VORTEX atom booklet with 1967 supplement and 1968 leaflets, abundantly illustrated by diagrams of new atomic and chemical structures for solving previously unsolved or incorrectly solved problems such as the duality of particle and wave, the benzene ring structure and the transition from the nonliving to the living. 25 cents. C. F. Krafft, 4809 Columbia Rd., Annandale, Virginia, 22003.

CHEMISTRY needs the alpha-eta configuration more than the electronic configuration. Brochure for 25 cents. V. M. Waage, 30 East 2nd Street, Apt. 22, Duluth, Minn. 55802.

WANTED—Theoretical physicist to scientifically explain a "Momentor", a new aerospace discovery. J. Ecklin, 40 Alexis, Woodbridge, Va. 22191

FORTUNES in formulas, 882 page book containing 10,000 processes and instructions for plastics, perfumes, wines, other beverages, ceramics, soaps, and thousands of others. Now only $4.95 pp. in U.S., other add 10%. R. C. Knaub, 2103 S. 71 S.D. 206, Milwaukee, Wisconsin 53219.

GALLIUM: The rare element metal that melts in your hand. Send $3.10 for a 1 gram sample. Catalog of unusual science buys 20¢. Franks Scientific Co., P.O. Box 156, Martelle, Iowa 52305.

GROW Gigantic Crystals! No expensive equipment! Instruction book—$2. SDJ, B-723, Metuchen, N.J. 08840.

CATALOG! Ver-ry interesting products. 25¢ or FREE with our Crystal Book! (see our other ad) SDJ, B-723, Metuchen, N.J. 08840.

UFO JOURNAL, The "Sentinel". New, different. Challenges censorship. News on UFO detectors, unexplained events on the moon, life on other planets, and much more. The origins, motives, and future activities of UFOs examined. Only $4.50 for 1 year (12 issues) or 50¢ for sample copy. A.R.S., Box 715, Banning, Calif. 92220

HYDROPONICS Grow plants without soil. Great science project. You receive three months supply of special formula and complete instructions. Send only $1.00 to Fraser Development Co., Dept. M, 1022 Chester Park Dr., Duluth, Minn. 55812

FOR INVENTORS

PATENT Searches complete and thorough. Related copies Air Mailed with maximum speed $6.00. Free "Protection Forms" and "Patent Information". Write American Patent Search Company, Dept. 29, 711 14th St., N.W., Washington, D. C. 20005.

INVENTIONS. Ideas—Searched—Developed—Marketed, formerly: United States Government Patent Examiner. Advisor, Raymond Lee, 75-N East 45 St., N.Y.C. 10017.

SOLAR Energy Enthusiasts-make the Sun's Rays work for you. Solar conversion, solar machines, furnaces, reflectors & lit. Free list: Solar Dynamics, Box 181, Thompsonville, Conn. 06082

INVENTIONS WANTED

INVENTIONS wanted in hardware, houseware, electro-mech, electronic, tool, personal & beauty access, toy & game, etc. We develop and manufacture. Established 35 years. Manufacturer, Bennett Associates, 250 W. 57th St., N.Y.C. 10019

INVENTIONS Wanted. Patented, unpatented. Global Marketing, 2420-AC 77th, Oakland 5, Calif.

INVENTORS! Don't sell your invention, patented or unpatented, until you receive our offer. Eagle Development Company, Dept. J. 79 Wall Street, New York 5, N. Y.

BOOKS, PERIODICALS

FUTURIST, New bimonthly, reports scientists' forecasts for next 50 years. $5 a year. World Future Society, Box 19285-D, Twentieth Street Station, Washington, D.C. 20036.

KNOW More about the earth you live on. Earth Science, bimonthly Magazine, Box 550S. Downers Grove, Ill. 60615. Subscription $2.50. Sample 35¢.

BACK Date Magazines! Send needs no catalog. Midtown Magazines, Inc., Box 934-SD, Maywood, N.J. 07607.

SCIENCE and Christian Faith, $1.00; Evolution and modern christian, $1.00. Christian Evidence League, Malverne, N.Y. 11565.

FREE! List of low cost popular books. Success, Golf, Business, Bowling, many others. Dixie Gift Mart, 1384-A Monroe Drive, N.E. Atlanta, Ga. 30324.

BOOKS Located—any subject. Hoffman Research Service, 124-K Whitmore Road, Irwin, Pa. 15642.

292 SELF-Help books on preparing for Civil Service jobs. Free list plus a large selection of other topics. DeBords, Box 1153-S1, Berkley, Michigan 48072

BATTERIES & GENERATORS

VX-6 PROLONGS life in old and new batteries, it keeps sulphation dissolved. Save, write, now. Elliott Sales, 1119 Warfield, Piedmont, Calif. 94610.

COLOR SLIDES

SELL your photos. Report tells how, where. Color slide markets. Only $1.00. Treasure Trove, 1511 Campus Dr., Tempe, Arizona 85281.

NOVELTIES

FOR the Prankster and Experimenter. Confuse, Amuse, Use. Unique lamp socket. $1.98 ppd. C. Seymour, 3514 Midway Dr. NW, Cedar Rapids, Ia. 62405.

BOOKPLATES

FREE Catalog—Many beautiful designs. Address Antioch Bookplate Co., Yellow Springs 13, Ohio.

EDUCATION AND INSTRUCTION

EARN College or High School diploma at home. All subjects. Free brochure. Ohio Christian College. 1156 Striebel Road, Columbus 13, Ohio 43227.

EXPERIMENT With sleep-learning! Fascinating, educational. Use your recorder, phonograph or amazing new Electronic Educator endless tape-recorder. Astonishing details, huge catalog of tapes, records, equipment free! Sleep-Learning Association. Box 24-SD, Olympia, Washington 98501.

LEMURIAN Viewpoint—Meaningful discussions of Cosmic Truth: the purpose of human life, reincarnation, man's place in a higher plan, and subjects from the Lemurian Philosophy. Send for free copy, Lemurian Fellowship, Dept. 804, Box 397, Ramona, Calif. 92065

EXPERT Penmanship complete course $1.00. Framar, 9 Disney Dr., Toms River, N.J. 08753

EARN A British diploma in Radionics, Botanic medicine, Homoeopathy, Super-Science, Divinity, Philosophy. 35 courses, prospectus free. Brantridge Forest School "Lodge", Brantridge Forest, Balcombe, Sussex, England.

COMPUTER PROGRAMMING-the big opportunity career. New recognized correspondence course. No maths needed. Free brochure. Canadian Institute of Science & Technology. 263X. Adelaide St. W., Toronto.

FINISH HIGH SCHOOL in 10 weeks. Easy, proven, low cost, adult program. EPI, Dept. A, Box 5026, Tucson, Ariz.

CATHOLIC Protection instructions $1.00, F. Knapp, P.O. Box 854, Scottsdale, Arizona 85252.

HIGHLY effective home study courses in Electronics engineering technology and electronics engineering mathematics. Be a graduate engineer of CIEE and raise yourself to engineering level pay and status. Free literature. Write Cook's Institute of Electronics Engineering, Forest Hill Road, Box 10634-SD, Jackson, Miss. 39209 (Established 1945).

TREASURE FINDERS

TREASURE Hunters! Prospectors! Relco's new instruments detect buried gold, silver, coins. Kits, assembled models. Transistorized. Weighs 3 pounds, $19.95 up. Free catalog. Relco-A88, Box 10839, Houston, Texas 77018.

FIND Buried treasure with new revolutionary analytical metal detector. Features push button tuning, automatic tuning, loudspeaker, negligible ground pickup, greatest range. Free catalog. Gardiner Electronics, Dept. 59, 4729 N. 7th Ave., Phoenix, Arizona 85013.

"GOLD, SILVER, RELICS! Located with powerful Detectron metal detectors. Free information. Terms. Detectron, Dept. 1-SD, Box 243, San Gabriel, Calif. 91778.

GOVERNMENT SURPLUS

JEEPS Typically from $53.90 . . . Trucks from $78.40 . . . Airplanes, Typewriters, Boats, Clothing, Camping, Sporting, Photographic, Electronics Equipment. Wide variety, condition. 100,000 Bid bargains direct from Government Nationwide. Complete sales directory and surplus catalog $1.00 (Deductible First $10.00 order). Surplus Service, Box 820-SD, Holland, Michigan 49423.

MAGIC TRICKS, PUZZLES, JOKER

FREE! World's leading catalog 2000 novelties, jokes, tricks, Scientific gadgets, hobbies, Johnson-Smith, D351, Detroit, Mich. 48224

STAMP COLLECTING

SCIENCE Topical issues astronomy to Zoology Free premium, Berchtold Stamps, Troy, Ohio 45373.

100 DIFFERENT Hungary 25¢. Approvals. Main Lee Co., P.O. Box 424 D, Ft. Lee, N.J. 07024.

ENGRAVED John F. Kennedy first day cover 35¢ 3 for $1.00. Artcraft, Box 66, Maplewood, N.J. 07040

121 DIFFERENT flag stamps free, W-B Stamp Co., Wilkes-Barre, Penna. 18703.

COIN COLLECTING

22 LINCOLN cents $2.10. 1968S-1955S VG-F. Mrs. Kendall, 409 Hazelwood, Warren, Ohio 44483.

AVIATION

ROCKET engines! Send for 68-page illustrated book "How to Design, Build and Test Small Liquid-Fuel Rocket Engines." List of suppliers included. $3.50 ppd. No COD. Rocketlab, Dept. SD-169, Box 5636, China Lake, Calif. 93555.

DO-IT-YOURSELF

WATER!! Drill your own well the easy, economical way with Amazing new Invention. Save 75%. Free information. DeepRock Drilling Co., Opelika, Ala. 36801.

HOME CRAFTSMAN

FREE Popular Mechanics 16 page illustrated catalog of publications, plans and projects. Booklet covers an extremely wide variety of do-it-yourself data on home remodeling shop tools and machines, car repair, hobbies, crafts, boating, games, lawn and garden and hundreds of others. For your free copy write to Service Bureau, Dept. PE, Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022.

AUTOMOBILES, MIDGET CARS

1968 CARS $999. 1967 cars only $699. Deliveries anywhere U.S.A. about 4¢ per mile. Free catalog. Assoc. Dealers, 40 Newbridge, Hicksville, N.Y. 11801

REAL ESTATE & FARMS

80 ACRES, Eminence, Missouri. $9500. Box 112 Brooklyn P. 12, N.Y.

PETS—BIRDS, CATS, HAMSTERS, ETC.

LIVE SEAHORSES, marine specimens aquarium supplies. Illustrated catalog 15¢, Marine, Box 248-204, Dania, Fla. 33004

RABBITS—FUR BEARING ANIMALS

MAKE Big Money raising chinchillas, guinea pigs, rabbits, mink or pigeons for us. Free information. Keeney Brothers Farms, New Freedom, Pa. 17349.

RAISE Rabbits for us on $500 month plan. Free details. White's Rabbitry, Mt. Vernon, Ohio 43050.

CARTOONING & COMMERCIAL ARTS

"HOW to make money with simple cartoons". Everyone who likes to draw should have this book; free. Write Cartoonists' Exchange, 2271 Pleasant Hill, Ohio 45359.

GIFT SHOPPING

FREE catalog. "Distinctive Gifts" for all occasions. D. W. Bahr, SD1268, 5860 Lilac Lane, Hales Corners, Wisconsin 53130.

MUSIC & MUSICAL INSTRUMENTS

POEMS, songs wanted for new song hits and recordings by America's most popular studio. Tin Pan Alley, 1650-SD Broadway, N.Y. 10019

SONGS, Poems wanted for publishing, recording at our expense! Talent, 17-S Longwood Road, Quincy, Mass. 02169

ATHLETIC & BODY BUILDING

"GIANT ARMS". Dr. Young's. D.C. Revolutionary Discovery. $2 Satisfaction or refund. Gaucho. Box 9309-S. Chicago, Ill. 60690

REMAILING SERVICE

GEORGIA REMAILS. Your secret address. Strict Confidence. Entersull, Box 188-D, Forsyth, Ga. 31029

WANT a Michigan or Indiana address? Sending or receiving confidential mail 50¢ single—$4.00 month. Oak Mailing, Box 55D, Burr Oak, Mich. 49030.

MAILORDER Records help get Increased Business! Complete 32 page Record Book shows your inquiries, orders, advertising expense, etc. Only $1.00. Martin, Popular Mechanics, Dept. S. D. R., 575 Lexington, New York 10022.

HELP WANTED

AUSTRALIA Wants you! Government assisted passage. Unlimited opportunities. Latest government information and forms $1.00. Austeo, Box 3623-P, Long Beach, California 90803.

PRINTING, MULTIGRAPHING, MIMEOGRAPHING, GUMMED LABELS

PROFESSIONAL Engraving, art design, offset & labels. Printing catalog 25¢ deposit. Sasons SD-1BP, Box 3030, San Antonio, Texas 78226.

ADVERTISING AGENCIES, ADV. SERVICE, MAILING LISTS

HOW to build friends for your business Advertising Novelties Brochure 25¢ deposit. Sasons, SD-1BS, Box 3030, San Antonio, Texas 78226.

PROFITABLE OCCUPATIONS

BECOME A mortgage broker. Earn 10,000 to 50,000 year. Complete details. United Mortgage Co., P. O. Box 2684-SD, Marietta, Georgia 30060.

SPECIAL SERVICES

AUSTRALIA: Remailing, souvenirs, coins special assignments, business rep. professional services. Box 38, Northbridge, NSW 2063, Australia.

RADIO, TELEVISION AND HAM EQUIPMENT

RECEIVE Police, Fire, emergency and regional high band continuous weather forecasts with an AUDITOR, a pocket size professional type police-fire receiver. $25.95 (includes postage). Specify high or low band model. Catalog. Custom Components, Dept. D. Box 352, Alden Manor, Elmont, N.Y. 11003.

TEST radio & TV tubes yourself. Test lamps, toasters, etc., plus auto circuits. Mod. FT078 only $3.25. Deluxe mod. FTO79 has picture tube socket & fuse test, only $4.49. Green's of Houston, 1926 Springrock, Houston, Texas 77055.

LONG Range TV reception easy! Booklet outlines methods to receive distant TV stations using inexpensive materials. $1.50 ppd. Practical Plans, Box 56-B, Killeen, Texas 76541.

RUBBER STAMPS, OFFICE SUPPLIES

AIR MAIL, special delivery, and First Class rubber stamps—$3.00. Dependable Service, 25670 Farringdon St., Euclid, Ohio 44132.

BUSINESS OPPORTUNITIES

OPERATE Restaurant. Free booklet reveals profitable plan. Write Restaurant Business School, Dept. JC-19, 1920 Sunnyside, Chicago, Ill. 60640.

IMPORT Export opportunity, profitable worldwide, mail-order business from home, without capital; or travel abroad. We ship proven plan, for no risk examination. Experience unnecessary. Free details. Mellinger, Dept. C-1871, Los Angeles 90025.

MONEYMAKING OPPORTUNITIES

MAKE Money at home—inside reports reveal 5 unusual small businesses you can start on a shoe string, run from your home. No door to door selling. Reports give facts, figures, case histories. How to Start. Money back guarantee. All 5 confidential reports only $2.98 ppd. Thorne & Caswell Co., 431 Eleanor Ave., Dept. B, Sebastopol, Calif. 95472.

$500—$800 MONTHLY Raise small laboratory-breeding stock for us. We supply equipment, breeders, instructions. Illinois Research Farms, Dept. DS-1, 2711 Justen, McHenry, Illinois 60050.

OPPORTUNITIES, ideas, helpful articles: "Goldmine Magazine" 25¢. Penman, Deerpark, N.Y. 11729

$10 DAILY writing short articles at home. Begin immediately! Copyrighted report reveals how and where. Send $1, Hamon's Gift Shop, South Van Brocklin Rd., Freeport, Illinois 61032.

PERSONAL

"SKIN Care Manual" $1.00. Boyman Enterprises Box 818-SD, Westminster, Calif. 92683.

DREAMS-LEARN their mysterious inner meanings! 110 page book, "How to Understand Your Dreams" Send $2.00, Tempo Center, 6355 N. Encinita Ave. Temple City, Calif. 91780 Calif. Res. add 5% tax.

BILLS Paid Without Borrowing—Nobody refused up to $18,000.00. Bad Credit No Problem—Not a Loan Company. Write for free application Internation Acceptance, Dept. SDC, 5133 N. Central Ave. Phoenix, Arizona 85012 — 711 14th St. NW, Washington, D.C. 20005 — 507 Carondelet St., New Orleans, La. 70130

MUSIC Lovers, continuous, uninterrupted background music from your FM radio, using new inexpensive adaptor. Free Literature. R. Clifton, 11500-A NW 7th Ave., Miami, Fla. 33168.

RESURRECTED Billions will farm ocean bottoms when seas removed by coming whirlwind! Free. Write: Harvest-SD, Jefferson City, Mo. 65101.

STAMMER-Stutter-no more. (Dr. Young) Write: Gaucho, Box 9309-S. Chicago 60690.

"PSYCHIC DOMINANCE—How to rule others with your thoughts." Full Course—with stirring Exercises. $3. Illustrated. Satisfaction or refund.—Clarion, Box 9309-S. Chicago, Ill. 60690.

DISPOSABLE tar-stop cigarette filter. Allows smoker to see deadly tar & sooty smoke particles accumulate. Reg. & Filter cigarette. Will not change flavor or taste. 10 day supply 59¢. Add 20¢ for postage & handling. Midwest Gifts, Box 64, Dept. A, Amery, Wis. 54001.

LETTERS

No hope for monorails

This is to comment on the article beginning on page 43 of the November issue ("Transportation: Wheels, wings and hulls for the year 2000"). In regard to monorail systems, it should be no surprise that these venerable systems have failed to secure adoption in the 140 years that they have been around. They have almost insuperable switching problems, and offer no advantage over standard duorail supported systems.

I also wish to comment on the material on page 53 dealing with automated highways. Steering is inherently not failsafe, if by leader cable. Positive mechanical guidance is acceptably reliable. But such vehicles cannot operate at less than safe braking distance, while manually driven automobiles often do, at least on Los Angeles freeways. This leads to frequent multiple car collisions, but the liability is then that of the individual drivers and not that of the operators of the automatic roadway. Therefore, capacity of an automatic highway is less, not more, than that of the ordinary freeway lane.

W. H. T. Holden
Professional Engineer
Pasadena, Calif.

Chameleon by a different name

Your October '68 issue claims, on page 19, ("Zap!") that the only true chameleons in North America are in zoos. Will you please tell me what the small lizards abounding in Florida are to be called? Among other lizards here, we have many, many small reptiles which change color from brown to bright green. They look like your picture on page 19 and fit the description.

Of course, they may be like the iguanas which live wild here and were originally imported. I know that even our palm trees began with coconuts washed in by the Atlantic Ocean. But everyone calls our small reptiles chameleons.

Estelle R. Lench
University of Miami
School of Medicine
Coral Gables, Fla.

The name "chameleon" is misapplied to the small lizard found in Florida—probably because it can change color like a chameleon. This American reptile is of the genus Anolis (Iguandae). The majority of chameleons, however,

belong to the genus Chamaelo—with some specimens belonging to Rhampholeon, Leandria and Brookesia.—Ed.

Thank you, Thank you.

I read with profound interest the article entitled "Rocket blasts and guinea pigs" in the October issue of *Science Digest*. Besides proving informative, the article appeared flawless from a standpoint of accuracy.

On behalf of the entire News Bureau and General Electric's Mississippi Test Support Department at Bay St. Louis, Miss., I would like to commend the author for this most objective report.

BERNARD ALLMAYER
News Bureau
General Electric

Another space theory

My letter is aimed toward those people who claim that they cannot understand the final sequences of the film "2001: A Space Odyssey." I suggest that they get hold of a copy of the book, which recently came out. The impression that I got was that the transformation of the astronaut David Bowman was part of an unimaginable plan, or scheme, by a non-biological entity to give a new shape to the universe, as the star-child returns to earth to watch while nuclear war begins and "history as men knew it would be drawing to a close."

RICHARD STERNBACH
Stamford, Conn.

Human, not beastly

Your September issue contained an article about the controversial issue of man's cultural beginnings. ("How

beastly of us," page 67.) Our scientific knowledge to date does not indicate that "man's cultural patterns also may have evolved from lower animals."

Evolution was challenged at a symposium by the Wistar Institute of Anatomy and Biology, and as a result, the Institute published a book entitled, "Mathematical Challenges to the Neo-Darwinian interpretation of Evolution," in June of last year. Dr. Murray Eden opened with a lecture on "Inadequacies of Neo-Darwinian Evolution as a Scientific Theory." He states, "The process of speciation by a mechanism of random variation of properties in offspring is usually too imprecisely defined to be tested. When it is precisely defined it is highly implausible."

Ashley Montagu, in his late book, "Man Observed," disagrees with the concept that man is brutish. Scientifically observed facts lead us to believe that animals have always been animals, and humans have always been humans.

HENRY LISTIAK
Phoenix, Ariz.

Index to Volume 64

SCIENCE DIGEST

July through December, 1968

Titles listed in italics are usually less than a full page in length. IBC indicates Inside Back Cover; IFC, Inside Front Cover.

AEROSPACE

Airmen Enter 400°F. Ovens ..... Dec. 29
Antenna Arrays ..... Oct. 41
Astronauts Train for Possible December Moon Trip ..... Nov. 4
Brilliant Comeback for Apollo Space Program ..... Dec. 4
Dead End on the Moon? ..... July 4
Earth Lab for Hostile Moon Microbes ..... Oct. 7
Gravitational Anomalies Pose Moon Landing Threat ..... Oct. 4
Hibernating Astronauts ..... Dec. 76
Laser Beams to Satellite ..... Aug. 36
Meteoroid Detector ..... Sept. 60
Nozzle Extension for Rocket Engine ..... Nov. 65
One UFO Is Identified ..... Sept. 4
The Promising Parawing .... Aug. IBC
Rocket Blasts and Guinea Pigs .. Oct. 63
The Russian Space Program on Display ..... Oct. 66
Russians Wrong on Venus ..... Dec. 27
Shower for Astronauts ..... Nov. 24
Twenty-foot Mirror for NASA ... Nov. 64
World of Inner and Outer Space .. Oct. 38

AGRICULTURE, BOTANY AND GARDENING

All-out War on the Flying Plague ..... Sept. 70
Bamboo—the Big Grass ..... Aug. 37
Counting the Hedgehogs ..... Nov. 21
Machine for Plant Nursery ..... July 42
New Day for the Dust Bowl ..... Aug. 12
Oldest Fossil on Earth? ..... Dec. 25
What Is a Slime Mold? ..... July 72
You Need ■ Big Mouth to Eat Dieffenbachia ..... Sept. 6

ANTHROPOLOGY AND ARCHAEOLOGY

Archaeology of Manhattan ..... Sept. 36
Case of Mistaken Mummy ..... Dec. 77
City of the Sacred Turtle: Nan Matol ..... Nov. 33
Columbus' Ships?—X Marks the Spot ..... Oct. 29
Device Finds Buried God ..... Aug. 33
Dispute Oldest Man in America .. Aug. 6
Face from 20,000 B.C. ..... July 39
5000-Year-Old Teeth ..... Aug. 79
Hot Pots ..... Aug. 6
Inside the Pyramids ..... July 40
Mummy Joe ..... July IFC
The Neanderthal Man: Is He One of Us? ..... Oct. 13
A New Look at Easter Island .... Aug. 25
Newspaper Rock ..... Sept. 39
Phoenicians in America? ..... July 6
Physics and the Pyramids ..... Aug. 40
Roman Ruins vs Schooldays ..... Dec. 27
Saint Peter's Bones? ..... Dec. 7
Serpent-bird of the Mayans .... Nov. IFC
13,000-Year-Old Fossil ..... July 41
Toothaches Among America's Earliest Inhabitants ..... Nov. 75
Tough Time for Pottery ..... Sept. 38
12-Million-Year-Old Tool ..... July 6
What Makes the Hippo So Blue? . Sept. 29
Who Were New England's Ancient Cave Dwellers ..... Oct. 35

ART AND CRAFTS

Spinning for Science ..... July 43
That Urge to Censor ..... July 67
Tough Time for Pottery ..... Sept. 38
Violins of the Future ..... Aug. 54
What Makes the Hippo So Blue? . Sept. 29

ASTRONOMY

Automated Classroom Planetarium ..... Sept. 25
Build a 4¼" Reflector Lens Telescope ..... Nov. 78
Mysterious Clocks in Space ..... Oct. 6
Pulsar Puzzle Deepens ..... July 4
Record Solar Flare ..... Sept. 4
Russians Wrong on Venus ..... Dec. 27
Solar Storms Predicted ..... Oct. 64
Stars Tell Their Age ..... Nov. 77
Sunspots—Hot or Cold? ..... Dec. 82

ATOMIC SCIENCE AND TECHNOLOGY

Cornell's New Synchrotron ..... Nov. 77
Subatomic "Bullets" ..... Oct. 82
Thyroid Damage From H-Bomb Fallout ..... Sept. 6

AUTOMOTIVE ENGINEERING

Air Pollution Reduced by Piston Ring ..... Nov. 65
Alcoholics and Accidents ..... Nov. 38
At the Drop of a Car ..... Sept. 34
"Drive Carefully" Slogans ..... Dec. 31
Dummies That Save Lives ..... Sept. 14
Inflatable Auto Jack ..... Aug. 63
Mini-racing Car ..... July 24
Oops! Load Lifts Truck ..... Sept. IBC
Roomy Glass Car ..... Sept. 24
Safety Headlamps ..... July 60
Self-service "Petro" Pumps ..... Sept. 25
Skid Control Device ..... July 4
Sniff Mask Measures Exhaust ... Sept. 61
To Drink or Drive? ..... Oct. 58
Transportation: Wheels, Wings and Hulls for the Year 2000 ... Nov. 43

AVIATION

Airmen Enter 400°F. Ovens ..... Dec. 29
Airplanes That Land on a Doughnut ..... Oct. 80
Bugs and Mid-air Collisions ..... Oct. 6
Ethics vs. Sick Pilots ..... Oct. 62
Fire Fighting in Vietnam ..... Dec. 53
Helicopter Rescue Basket ..... Nov. 25
Jet Flying Belt ..... Sept. 37
Landings and Take-offs Tested .. Aug. 33
The New Flying Machines ..... Aug. 82
The Promising Parawing ..... Aug. IBC
10-inch Diameter Fly Wheel Tested ..... Aug. 52
Transportation: Wheels, Wings and Hulls for the Year 2000 .. Nov. 43
Turning Night Into Day ..... Aug. 52

BIOLOGY

Boys or Girls to Order May Backfire ..... Nov.
Chromosome Count ..... Aug. 4
Computer Used in DNA Examinations ..... Aug. 78
Conscious of Death ..... Sept. 68
Contagious Sterility ..... July 40
Darwin Back in Court ..... Dec.
Drug Dangers ..... July 62
Earth Lab for Hostile Moon Microbes ..... Oct. 7
Hormone for the Bones ..... Sept. 62
How Beastly of Us ..... Sept. 67
How Do Animals Communicate? . Nov. 87
Lefties Made, Not Born ..... Nov. 22
Long-lived Scientists ..... Aug. 36
Multimouse ..... Aug. 4, 35
Nutritional Effects on Size ..... Sept. 63
78 Chromosomes=One Dog ..... Oct. 39
Test-tube Evolution ..... Nov. 76
Vitamin Treatment of Mental Illness ..... Aug. 6
Water-breathing People? ..... Nov. 76
What Happens When You Stop Smoking? ..... Dec. 19
What Is a Slime Mold? ..... July 72
Why Fat People Keep Eating .... July 66

BOOK REVIEWS

Before the Deluge, by Herbert Wendt ..... July 77
A Paradise of Birds, by Helen Gere Cruickshank ..... July 78
Flashing Wings, by John K. Terres ..... July 78
Men Who Dig Up History, by Lynn and Gray Poole ..... July 78
High Energy Physics, by Hal Hellman ..... July 78
The Lovely and the Wild, by Louise de Kiriline Lawrence .. July 78
Southern Seashores, by William M. Stephens ..... July 79
Unusual Aquarium Fishes, by Alan Mark Fletcher ..... July 79
The Forging of Our Continent, by Charlton Ogburn Jr. ..... July 79
Mound Builders of Ancient America, by Robert Silverberg. Aug. 89
Light and Electricity in the Atmosphere, by Hal Hellman. Aug. 90
The Marvelous Animals, by Helena Curtis ..... Aug. 90
An American Genuius, by Herbert Childs ..... Aug. 90
Science, Numbers, and I, by Isaac Asimov ..... Aug. 90
The Promise of Space, by Arthur C. Clarke ..... Aug. 91
Man and the California Condor, by Ian McMillan ..... Aug. 91
Galileo: Man of Science, ed. by Ernan McMullin ..... Aug. 91
A Field Guide to the Mammals of Britain and Europe, by F. H. van den Brink ..... Aug. 91
Vanishing Tribes, by Roy Pinney ..... Sept. 92
Gemini, by Gus Grissom ..... Sept. 93
Rockets, Missiles, and Men in Space, by Willy Ley ..... Sept. 93
The Senses of Man, by Joan Steen Wilentz ..... Sept. 93
How to Kill a Golden State, by William Bronson ..... Sept. 93
Seals of the World, by Gavin Maxwell ..... Sept. 94
Man, Medicine, and Environment, by René Dubos ..... Sept. 94
Killer Smog, by William Wise .. Sept. 94
The Biological Time Bomb, by Gordon Rattray Taylor ..... Oct. 88
The Evidence of Evolution, by Nicholas Hotton III ..... Oct. 89
The Story of Jodrell Bank, by Sir Bernard Lovell ..... Oct. 89
Honeybees From Close Up, by Arthur M. Dines ..... Oct. 89
The Right Size, by Hal Hellman .. Oct. 89
Kilauea: Case History of a Volcano, by Don Herbert and Fulvio Bardossi ..... Oct. 89
The Population Bomb, by Dr. Paul R. Ehrlich ..... Oct. 90
Astronomical Objects for Southern Telescopes, by E. J. Hartung .. Oct. 90
Animal Locomotion, by Sir James Gray ..... Oct. 90
Heavy Weather Sailing, by K. Adlard Coles ..... Nov. 92
The King Snake, by Allan W. Eckert ..... Nov. 94
The SST. Here It Comes, Ready or Not, by Don Dwiggins ..... Nov. 94
Glacial and Periglacial Geomorphology, by Clifford Embleton and Cuchlaine A. M. King ..... Nov. 94
The Atlantic Salmon: A Vanishing Species?, by Anthony Netboy .. Nov. 94
Appointment on the Moon, by Richard S. Lewis ..... Dec. 88
Too Short a Day. A Woman Vet in Africa, by Susanne Hart .... Dec. 89
Toward the Year 2000, edit by Daniel Bell ..... Dec. 89
Birds of the Eastern Forest, by John A. Livingston ..... Dec. 89
Soil Animals, by Friedrich Schaller ..... Dec. 89
The Mirages of Marriage, by William J. Lederer and Dr. Don D. Jackson ..... Dec. 89
Science for the Airplane Passenger, by Elizabeth A. Wood ..... Dec. 90
McGraw-Hill Modern Men of Science Volume II ..... Dec. 90
The Lost Americans, by Frank C. Hibbens ..... Dec. 90
Illusions, by André Maurois ... Dec. 90

CANCER

Blood Treated Outside Body .....Aug. 65
Cancer and Emotions .....July 6
Cancer—Delay May be Deadly ..Nov. 66
Cancer Drug at Lower Cost .....Dec. 63
Cancer of Cervix Tied to VD Virus .....Nov. 6
Hodgkin's Prognosis .....Aug. 66
Test-tube Evolution .....Nov. 76
What Happens When You Stop Smoking? .....Dec. 19

CHEMISTRY

Chemically Strengthened Glass ...Oct. 56
DDT—Indiscriminate Killer ....Aug. 79
Liquid Crystals .....Dec. 32

COMMUNICATIONS

"Electronic Eyeball" .....Oct. 57
Electronic Telephone .....Aug. 62
How Do Animals Communicate? .Nov. 87
Improved PICTUREPHONE Tested .....July 24
Personal Two-way Radio .....Nov. 27
Scientists Versus Syntax .....July 42
Send Documents by Telephone ...Oct. 81
Smallest Citizens Band Radio ...July 24
Talking Binoculars .....Dec. 30
Telephones for Deaf .....Oct. 23
TV Dial Offers Continuous Tuning .....Sept. 24
You Can't Translate Love .....Sept. 38
You Dance to Words! .....Oct. 40

DENTISTRY

Barnacle Glue for Cavities .....Oct. 61
5000-Year-Old Teeth .....Aug. 79
Hot Foods Shrink Fillings .....July 70
Mobile Dental Vans .....Oct. 40
Plaster Skull Models .....Aug. 77
Rubber Gums for Dentures .....Nov. 67
Toothaches Among America's Earliest Inhabitants .....Nov. 75
Why Our Teeth Fall Out .....July 65

DRUGS AND ANTIBIOTICS

Becoming Immune to Disease ....Sept. 90
Britons Warned on Pill .....Nov. 25
Cancer Drug at Lower Cost .....Dec. 63
Drug Dangers .....July 62
German Measles on the Way Out? .....Dec. 5
Get That Dope! .....July 43
If It's "Pot," Don't Panic .....Oct. 62
LSD in Middle Ages .....Dec. 29
Marijuana Condemned .....Aug. 4
Muscle Drugs Scorned .....Sept. 64
New Drug for Parkinson's .....Aug. 68
No Protection From Aspirin Damage .....Dec. 5
One Shot for Mumps and Two Measles .....Nov. 6
Powerful, Safe Painkiller .....Sept. 26
Spray Better Than Flu Shot ....Aug. 66
Stitches That Kill Bacteria Save Lives .....Aug. 64
Turned on Canaries .....Nov. 24
What Became of the Rub-on Wonder Drug DMSO? .....Sept. 7

EDUCATION AND CAREERS

Automated Classroom Planetarium .....Sept. 25
Career, Anyone? .....Sept. 81
Chamber for Radioactive Material .....Dec. 30
Computers for Students .....Aug. 62
Darwin Back in Court .....Dec. 6
Hibernation Improves Learning ..July 6
Space Age Career Men .....Oct. 73
That Urge to Censor .....July 67
Wanted: 300,000 Technologists .Aug. 80
What Children Teach Themselves to Draw .....Aug. 22

ELECTRONICS AND ELECTRICITY

Amputees "Think" Control .....Dec. 64
Antenna Arrays .....Oct. 41
Antenna Predicts Weather .....Nov. 21
Ceramic Circuits .....Nov. 65
Digital Fossil Filing .....Oct. 42
"Electronic Eyeball" .....Oct. 57
"Energy Paper" Powers Shaver .Nov. 26
How Science Can Map Your Voice .....Nov. 28
Japanese Pen Recorder .....Sept. 60
Krypton Light Bulb .....Oct. 23
Liquid Crystals .....Dec. 32
Miniature Radar .....July 60
New Dielectric System .....July 61
Personal Two-way Radio .....Nov. 27
Portable Acoustic Data Coupler .Sept. 61
Radar Antenna of the Future ....Oct. 56
Radio Station B.U.S. .....July 4
Smallest Citizens Band Radio ....July 24
Smallest Mercury Light Bulb ....Dec. 31
Superconductivity—Deep-frozen Electricity .....Oct. 43
Talking Binoculars .....Dec. 30
Thought-control of Artificial Arms .....Dec. 30
Visual Characters from Spoken Words .....Oct. 56

ENTOMOLOGY (See insects)

EXPLORATION

Antarctica's Mysterious Volcanoes .....July 26
Did Cook Beat Peary to the Pole? .....Sept. 40
Inside the Pyramids .....July 40
New Look at Easter Island .....Aug. 25

EYES AND VISUAL AIDS

The Deeper the Bigger .....Dec. 78
Eye Boggles at 6,000,000 .....Nov. 24
Eye Movement and Driving .....Nov. 67
Goggles Allow Skiers to Maneuver .....Dec. 30
Indoor/Outdoor Eyeglasses .....Nov. 27
New Irritant in Smog .....Oct. 40
The "Stick-on" Eye Lens .....Oct. 60

FOOD AND DIET

Charcoal Filtered Cows .....July 70
Cheery Side of Fatness .....Oct. 59
Chemical Diet .....Aug.
Gnu Steaks Are New .....Dec. 5
Hot Foods Shrink Fillings .....July 70

How Much Can Your Stomach Take? ..... Sept. 86
Industrial Waste for Food ..... Sept. 69
Malnutrition and I.Q. ..... Aug.
Nutritional Effects on Size ..... Sept. 63
Orange and Grapefruit Tablets ..... Nov. 23
Protein From Petroleum ..... Dec. 28
Whale Farming in a Coral Corral ..... Dec. 47
Why Fat People Keep Eating ..... July 66
Why Our Teeth Fall Out ..... July 65

GEOLOGY

Antarctica's Mysterious Volcanoes ..... July 26
Fish Predict Quakes? ..... Sept. 37
Oldest Fossil on Earth ..... Dec. 25
The Shape of the Columbia Plateau ..... Oct. 83
What Volcano? ..... Dec. 78

HEARING

Hearing Tests for Infants ..... Nov. 66
Rocket Blasts and Guinea Pigs ..... Oct. 63
Telephones for Deaf ..... Oct. 23

HEART AND BLOOD

Artificial Blood ..... Sept. 38
Artificial Valves Do the Job ..... Aug. 65
Blood Treated Outside Body ..... Aug. 65
Control for Hemorrhages ..... Sept. 65
New Bleeders' Aid ..... Nov. 70
Patient's Blood Re-used ..... Oct. 60
Shrinking Hearts ..... Oct. 4
Sleep for the Heart ..... July 63
Sleep Your Way to a Heart Attack ..... Dec. 6
Slowing Down Senility ..... Sept. 66
Transplant Heart Preserved for a Day ..... Sept.

HOUSING AND HOME AIDS

All-Purpose Spray Adhesive ..... July 25
Ellipsoid-shaped House ..... Nov. 26
"Energy Paper" Powers Shaver ..... Nov. 26
Gaslighter for Gas Appliances ..... Oct. 23
Hardware to Help You Sleep ..... July 29
Imaginative Nursery Furniture ..... Oct. 23
Indoor-Outdoor Rotisserie-Broiler ..... Nov. 26
Krypton Light Bulb ..... Oct. 23
Plastic Inflatable Armchair ..... July 25
Sea City ..... Dec. 60

INDUSTRY AND ENGINEERING

Acrylic Lens ..... July 61
Air Cushion Vehicle Lab ..... Sept. 61
All-purpose Spray Adhesive ..... July 25
Aluminum Hemispheres ..... Dec. 52
Antenna Arrays ..... Oct. 41
Archaeology of Manhattan ..... Sept. 36
At the Drop of a Car ..... Sept. 34
Beam Digs Tunnel ..... Aug. 35
Build a 4¼" Reflector Lens Telescope ..... Nov. 78
Career, Anyone? ..... Sept. 81
Ceramic Circuits ..... Nov. 65
Chemically Strengthened Glass ..... Oct. 56
A Clean Swim ..... Aug. 35
Compact Laser System ..... Aug. 53
Computer Used in DNA Examinations ..... Aug. 78
Computers for Students ..... Aug. 62
Cooling Off Outside ..... Sept. 13
Creeping Fire Underground ..... Sept. 20
Device Finds Buried God ..... Aug. 33
Digital Fossil Filing ..... Oct. 42
Disc-shaped Magnets ..... Nov. 64
Dummies That Save Lives ..... Sept. 14
"Electronic Eyeball" ..... Oct. 57
Electronic Telephone ..... Aug. 62
"Fast Fix" Cement for Vietnam ..... Nov. 65
Fire Fighting in Vietnam ..... Dec. 53
First Portable X-ray Unit ..... Dec. 53
Fused Silica Mirror ..... Aug. 52
Get Hot With COED ..... July 80
Giant High-Pressure Chamber ..... Oct. 57
Heat Photography—New Tool for Science ..... Dec. 35
How Science Can Map Your Voice ..... Nov. 28
Improved PICTUREPHONE Tested ..... July 24
Industrial Waste for Food ..... Sept. 69
Infrared Spectroscopy ..... Oct. 57
Instant Mobile Teletype Terminals ..... Aug. 53
It's a Holie Terra! ..... Nov. 84
Japanese Pen Recorder ..... Sept. 60
Jet Flying Belt ..... Sept. 37
Largest and Fastest Cargo Vessel ..... Aug. 52
Laser Uses Circulating Liquid ..... Nov. 64
Metals Strike Back ..... July 44
Meteoroid Detector ..... Sept. 60
Miniature Radar ..... July 60
Miniaturized Accelerometer ..... Oct. 57
Most Powerful Locomotive ..... July 61
New Dielectric System ..... July 61
New Leak Test Method ..... Dec. 52
No Hope for the Top ..... Dec. 28
Nozzle Extension for Rocket Engine ..... Nov. 65
Operation Bah-room ..... Nov. 85
Pistol Thermometer Eliminates Contact ..... Dec. 26
Polyester Chips for Yarn ..... Dec. 27
Portable Acoustic Data Coupler ..... Sept. 61
Protein From Petroleum ..... Dec. 28
Proton-scattering Microscope ..... Oct. 57
Radar Antenna of the Future ..... Oct. 56
Radio Station B.U.S. ..... July 4
Rescue of the Hidden Oil at Bayou Blue ..... Sept. 77
Reverse Osmosis Water System ..... Dec. 53
Rocket-powered Trains ..... Nov. 25
Rubber Water ..... July 61
Safety Headlamps ..... July 60
Sea City ..... Dec. 60
Self-service "Petro" Pumps ..... Sept. 25
Send Documents by Telephone ..... Oct. 81
Shrinking Hearts ..... Oct. 4
Slide Rule Diagnoses Diseases ..... Aug. 32
Smallest Mercury Light Bulb ..... Dec. 31
Sniff Mask Measures Exhaust ..... Sept. 61
Solar Simulator Checked ..... Dec. 52
Space Age Career Men ..... Oct. 73
Space Research Process ..... Sept. 60
Spiraling Steel Tape ..... Aug. 62
Subway Proposed to Save Venice ..... Dec. 5
Superconductivity—Deep-frozen Electricity ..... Oct. 43
Technical Symbols Typed ..... Aug. 63
10-inch Diameter Fly Wheel Tested ..... Aug. 52

"This Bottle Will Self-destruct" ..... Sept. 35
Tough Time for Pottery ..... Sept. 38
Transportation: Wheels, Wings and Hulls for the Year 2000 .. Nov. 43
The Turbo Train ..... Sept. 36
Turning Night Into Day ..... Aug. 52
Twenty-foot Mirror for NASA .. Nov. 64
Two-headed Camera ..... July 60
Ultra-fine Talc ..... Sept. 60
Underwater Meter Reader ..... Dec. 52
Underwater Shock Measuring System ..... July 61
Violins of the Future ..... Aug. 54
Visual Characters from Spoken Words ..... Oct. 56
Wanted: 300,000 Technologists .. Aug. 80
What Makes the Hippo So Blue? ..... Sept. 29

INSECTS

All-out War on the Flying Plague ..... Sept. 70
Contagious Sterility ..... July 40
Ecological Merry-go-round ..... Sept. 6
Marvelous Miniature Monsters .... Dec. 73
May Fly Memories ..... July 19
Operation on an Insect's Brain .. Dec. 13
Sensitive Moth Antennas ..... Nov. 24

INVENTIONS, PATENTS AND PROCESSES

400 Photos on a 2¼" Negative . Sept. 76
Get Hot With COED ..... July 80
It's a Holle Terra! ..... Nov. 84
The New Flying Machines ..... Aug. 82
Portable Oxygen Belts ..... Dec. 72
Send Documents by Telephone ... Oct. 81

MARINE BIOLOGY

Bringing Killer Whales Back Alive—Underwater ..... July 7
Cultivated Catfish ..... Oct. 42
DDT—Indiscriminate Killer .... Aug. 79
Fish Predict Quakes? ..... Sept. 37
More Killer Whales ..... July 6
Safer Way to Wash Water ..... July 67
Taming the Timid Sea Cows .... July 22
Walking Catfish ..... Nov. 22
Whale Farming in a Coral Corral ..... Dec. 47

MEDICINE

Alcoholics and Accidents ..... Nov. 38
America's $400,000,000 Headache ..... Aug. 17
Amputees "Think" Control ..... Dec. 64
Artificial Blood ..... Sept. 38
Artificial Valves Do the Job ..... Aug. 65
Baby Mortality High in U.S. .... Dec. 26
Barnacle Glue for Cavities ..... Oct. 61
Becoming Immune to Disease ... Sept. 90
Best Drink of All ..... July 41
Blood Treated Outside Body ..... Aug. 65
Bloodless Knife ..... July 65
Britons Warned on Pill ..... Nov. 25
Cancer and Emotions ..... July 6
Cancer—Delay May Be Deadly .. Nov. 66
Cancer Drug at Lower Cost ..... Dec. 63
Cancer of Cervix Tied to VD Virus ..... Nov. 6
Cheery Side of Fatness ..... Oct. 59
"Common Cold" Prevention Studied ..... Dec. 83
Control for Hemorrhages ..... Sept. 65
Disposable Skin Test Device ..... Dec. 31
"Drive Carefully" Slogans ..... Dec. 31
Drug Dangers ..... July 62
Ethics vs Sick Pilots ..... Oct. 62
Exercising for the Retarded .... Sept. 62
Eye Movement and Driving ..... Nov. 67
The Family Doctor Is Coming Back ..... Nov. 13
Fast Hernia Surgery ..... Oct. 61
First Portable X-ray Unit ..... Dec. 53
Flat Feet Can Be Normal ..... Nov. 68
German Measles on the Way Out? . Dec. 5
Germfree Baby Delivery ..... Dec. 31
Girls Smoking More ..... Sept. 66
Handling Sleepless Children ..... Dec. 65
Hardware to Help You Sleep .... July 29
Hearing Tests for Infants ..... Nov. 66
Heat Photography—New Tool for Science ..... Dec. 35
Hibernating Astronauts ..... Dec. 76
Hodgkin's Prognosis ..... Aug. 66
Hormone for the Bones ..... Sept. 62
Hot Foods Shrink Fillings ..... July 70
If It's "Pot" Don't Panic ..... Oct. 62
Insomnia? How About Electrosleep?" ..... Nov. 6
Is Neurosis a Bad Habit? ..... Aug. 69
It's Only a Virus ..... Oct. 85
Keep Your Headache ..... July 6
Last of the Barber Surgeons .... Dec. 79
Metal Knee Joints ..... Aug. 67
Muscle Drugs Scorned ..... Sept. 64
New Bleeders' Aid ..... Nov. 70
New Drug for Parkinson's ..... Aug. 68
No Protection From Aspirin Damage ..... Dec. 5
Nutritional Effects on Size ..... Sept. 63
The Obstetrician Shortage ..... Dec. 63
The Oldest Medicine—Wine .... Aug. 75
One Shot for Mumps and Two Measles ..... Nov. 6
Patient's Blood Re-used ..... Oct. 60
Pistol Thermometer Eliminates Contact ..... Dec. 26
Portable Oxygen Belts ..... Dec. 72
Powerful, Safe Painkiller ..... Sept. 26
Praise for the Jogger ..... Nov. 69
Premature Aging ..... Oct. 59
A Prenatal Checkup ..... Aug. 68
Regrowing Human Organs ..... Dec. 65
Rubber Gums for Dentures ..... Nov. 67
Seven-day Hospital Week ..... Dec. 66
"Shock Cart" ..... Oct. 23
Shrinking Hearts ..... Oct. 4
Sleep for the Heart ..... July 63
Sleep Your Way to a Heart Attack . Dec. 6
Slide Rule Diagnoses Diseases .. Aug. 32
Slowing Down Senility ..... Sept. 66
Smokers—What Kind Are You? . July 64
Smoking Cuts Reflexes ..... July 68
Spinning for Science ..... July 43
Spray Better Than Flu Shot ... Aug. 66
The "Stick-on" Eye Lens ..... Oct. 60
Stitches That Kill Bacteria Save Lives ..... Aug. 64
Student Suicides Mount ..... Aug. 65
A Tan That Lasts ..... Sept. 63
Ten Types of Patients That Doctors Deplore ..... Dec. 62
Test-tube Evolution ..... Nov. 76
"Think Posture" ..... Sept. 65
Thought-control of Artificial Arms ..... Dec. 30

Thymus Transplant Works .....Aug. 67
Thyroid Damage From H-Bomb Fallout .....Sept. 6
Timing the Stutterer .....Sept. 64
To Drink or Drive? .....Oct. 58
A Toast to the Hen House ....Dec. IBC
Transplant Heart Preserved for a Day .....Sept. 6
Ulcers .....Oct. 30
What Became of the Rub-on Wonder Drug DMSO? .....Sept. 7
What Can We Really Do for Arthritis? .....Dec. 67
What Happens When You Stop Smoking? .....Dec. 19
What Is An Allergy? .....Aug. 87
Why Fat People Keep Eating ...July 66
Why Our Teeth Fall Out .....July 65
Zoonoses—Animal Diseases You Can Catch .....Dec. 14

METEOROLOGY

Antenna Predicts Weather .....Nov. 21
Changing the Weather .....Nov. 89
The World's Worst Weather ....Aug. 46

MILITARY SCIENCE

Electro-Chemical People-Sniffers Spot Enemy .....Oct. 6
Heat Photography—New Tool for Science .....Dec. 35
Helicopter Rescue Basket .....Nov. 25
It's a Holie Terra! .....Nov. 84
Lightning-proof Tent .....Oct. 23
Spiraling Steel Tape .....Aug. 62

MINERALOGY AND METALLURGY

Creeping Fire Underground ....Sept. 20
Get Hot With COED .....July 80
Gulf Depths Yield Oil .....Dec. 29
Metals Strike Back .....July 44
Mystery Mineral Found .....Dec. 28
Out of This World Animal .....July 69
Rescue of the Hidden Oil at Bayou Blue .....Sept. 77
Rubber Water .....July 61

MISCELLANEOUS

Did Cook Beat Peary to the Pole? .....Sept. 40
The Greatest Scientist Ever ....Aug. 86
Oops! Load Lifts Truck .....Sept. IBC
Weights and Measurements .....Dec. 85

OCEANOGRAPHY AND NAUTICAL SCIENCE

Air Cushion Vehicle Lab .....Sept. 61
Aluminum Hemispheres .....Dec. 52
Birth of the Oceans .....July 71
The Deeper the Bigger .....Dec. 78
Giant High-Pressure Chamber ..Oct. 57
Great Gulf Stream Drift .....July 34
Gulf Depths Yield Oil .....Dec. 29
How Deep Is the Ocean? .....Aug. 83
Largest and Fastest Cargo Vessel .August. 52
"Planesail"—Aerodynamic Trimaran .....Nov. 27
Pressures of the Deep .....Nov. 23
Sealab III .....Nov. 7
Underwater Meter Reader .....Dec. 52
Underwater Shock Measuring System .....July 61
Water-breathing People? .....Nov. 76
World of Inner and Outer Space .Oct. 38

ORNITHOLOGY

Hens Lay More Eggs to Music ...Nov. 4
London Is for Birds Again .....Oct. 42
A Toast to the Hen House ....Dec. IBC
Turned on Canaries .....Nov. 24

PALEONTOLOGY

Digital Fossil Filing .....Oct. 42
The Horse of the Caveman .....Sept. 55
Oldest Fossil on Earth? .....Dec. 25

PHOTOGRAPHY

400 Photos on a 2¼" Negative ..Sept. 76
Fused Silica Mirror .....Aug. 52
Green for Go .....Sept. 24
Heat Photography—New Tool for Science .....Dec. 35
Pistol Thermometer Eliminates Contact .....Dec. 26
Two-headed Camera .....July 60

PHYSICS

Birth of the Oceans .....July 71
Cornell's New Synchrotron .....Nov. 77
Faster Than Light .....Nov. 86
The Greatest Scientist Ever ....Aug. 86
"Irresistible vs Immovable" ....Sept. 89
Physics and the Pyramids .....Aug. 40
Subatomic "Bullets" .....Oct. 82

PHYSIOLOGY

Excercising for the Retarded ...Sept. 62
Hibernating Astronauts .....Dec. 76
Praise for the Jogger .....Nov. 69
Premature Aging .....Oct. 59
Slowing Down Senility .....Sept. 66
What Happens When You Stop Smoking? .....Dec. 19

PLASTICS

The Celluloid Collar and Other Plastics .....July 74
Plastic Inflatable Armchair .....July 25

POLLUTION OF ENVIRONMENT

Air Pollution Reduced by Piston Ring .....Nov. 65
Charcoal Filtered Cows .....July 70
A Clean Swim .....Aug. 35
DDT—Indiscriminate Killer .....Aug. 79
Industrial Waste for Food .....Sept. 69
London Is for Birds Again .....Oct. 42
New Irritant in Smog .....Oct. 40
Safer Way to Wash Water .....July 67
Ultra-fine Talc .....Sept. 60

PSYCHIATRY AND PSYCHOLOGY

Alcoholics and Accidents .....Nov. 38
America's $400,000,000 Headache .....Aug. 17
Cancer and Emotions .....July 6
Chromosome Count .....Aug. 4
Conscious of Death .....Sept. 68
Exercising for the Retarded ....Sept. 62
Handling Sleepless Children ....Dec. 65
Hardware to Help You Sleep ....July 29

Insomnia? How About "Electrosleep?" ..... Nov. 6
Is Neurosis a Bad Habit? ..... Aug. 69
Keep Your Headache ..... July 6
Malnutrition and I.Q. ..... Aug. 6
The Oldest Medicine—Wine .... Aug. 75
"Perfect" Child Has Problems ... Aug. 67
Poverty and Mental Illness .... Sept. 46
Psychoanalysis Heads for Its Own Couch ..... Nov. 58
The Psychopathology of Big Business ..... Oct. 24
Radios Disturb Dreams ..... Oct. 41
Simian Society ..... Dec. 54
Student Suicides Mount ..... Aug. 65
Timing the Stutterer ..... Sept. 64
Violence Affects Brain ..... Oct. 64
Vitamin Treatment of Mental Illness ..... Aug. 6
What Children Teach Themselves to Draw ..... Aug. 22
You Can't Translate Love ..... Sept. 38
You Dance to Words! ..... Oct. 40

QUIZZES

The Celluloid Collar and Other Plastics ..... July 74
Changing the Weather ..... Nov. 89
How Deep Is the Ocean? ..... Aug. 83
How Much Can Your Stomach Take? ..... Sept. 86
It's Only a Virus ..... Oct. 85
Weights and Measurements ..... Dec. 85

RADIATION AND LIGHT

Chamber for Radioactive Material ..... Dec. 30
Compact Laser System ..... Aug. 53
Faster Than Light ..... Nov. 86
First Portable X ray Unit ..... Dec. 53
Laser Beams to Satellite ..... Aug. 36
Laser Uses Circulating Liquid .. Nov. 64
Low-cost Laser for Schools ..... Aug. 63
Premature Aging ..... Oct. 59
Pulsar Puzzle Deepens ..... July 4
Solar Simulator Checked ..... Dec. 52
Sunspots—Hot or Cold? ..... Dec. 82

REPTILES

How We Found Mexico's "Extinct" Tortoises ..... Aug. 7
Marvelous Miniature Monsters .. Dec. 73
New Skin for an Old Snake .... Sept. 32
A Snake's Life Isn't Easy ..... Sept. 69
Those Speedy Dinosaurs ..... Aug. 77
Zap Goes the Chameleon! ..... Oct. 19

SMOKING

Girls Smoking More ..... Sept. 66
Light up; Cool off ..... Oct. 42
Smokers—What Kind Are You? . July 64
Smoking Cuts Reflexes ..... July 68
What Happens When You Stop Smoking? ..... Dec. 19

SOCIOLOGY

Boys or Girls to Order May Backfire ..... Nov. 6
How Beastly of Us ..... Sept. 67
Long-lived Scientists ..... Aug. 36
Poverty and Mental Illness .... Sept. 46
Race and Crime ..... July 56

SPORTS AND RECREATION

Galway Blazer II Catches a Whisper of a Wind ..... Oct. 23
Goggles Allow Skiers to Maneuver ..... Dec. 30
Lightning-proof Tent ..... Oct. 23
Mini-racing Car ..... July 24
Praise for the Jogger ..... Nov. 69
Propellerless Aqua Scooters .... Sept. 25

TRAVEL AND TRANSPORTATION

Did Cook Beat Peary to the Pole? ..... Sept. 40
Most Powerful Locomotive ..... July 61
Rocket-powered Trains ..... Nov. 25
Subway Proposed to Save Venice .. Dec. 5
Transportation: Wheels, Wings and Hulls for the Year 2000 ..... Nov. 43
The Turbo Train ..... Sept. 36

ZOOLOGY

Animal Marriage Bureau ..... Aug. 32
Antlers Fine As Radiators ..... Oct. 65
Artificial Limb for Racehorse ... Dec. 28
The Better to Win Prizes With . Oct. IFC
Biped Poodle ..... Oct. 72
Bringing Killer Whales Back Alive—Underwater ..... July 7
Charcoal Filtered Cows ..... July 70
Counting the Hedgehogs ..... Nov. 21
Earthworm: At Home Underground ..... Nov. 71
Ecological Merry-go-round ..... Sept. 6
Elephants and Rhinos Are Vietnam Casualties ..... Nov. 6
Get That Dope! ..... July 43
Gnu Steaks Are New ..... Dec. 5
Hands Cold, Honey? ..... Sept. IFC
Hens Lay More Eggs to Music ... Nov. 4
Hibernation Improves Learning .. July 6
The Horse of the Caveman .... Sept. 55
How Beastly of Us ..... Sept. 67
How Do Animals Communicate? . Nov. 87
How to Eat Your Cake and Live in It Too ..... Nov. IBC
How We Found Mexico's "Extinct" Tortoises ..... Aug. 7
The Impossible Baby ..... July IBC
Insulated Horns ..... Sept. 36
London Is for Birds Again ..... Oct. 42
Marvelous Miniature Monsters .. Dec. 73
Miss Muffet, Where Are You? .. Oct. IBC
The Misunderstood Gorilla .... Aug. IFC
More Killer Whales ..... July 6
Multimouse ..... Aug. 4, 35
New Skin for an Old Snake .... Sept. 32
Operation Bah-room ..... Nov. 85
Out of This World Animal ..... July 69
The Pup Runneth Over ..... Dec. IFC
78 Chromosomes = One Dog ..... Oct. 39
Simian Society ..... Dec. 54
A Snake's Life Isn't Easy ..... Sept. 69
Taming the Timid Sea Cows .... July 22
Those Speedy Dinosaurs ..... Aug. 77
A Toast to the Hen House .... Dec. IBC
The Vanishing Bandicoot ..... Dec. 46
Whale Farming in a Coral Corral ..... Dec. 47
What Volcano? ..... Dec. 78
Zap Goes the Chameleon! ..... Oct. 19
Zoonoses—Animal Diseases You Can Catch ..... Dec. 14

BIPS

Broken Crockery?

WHAT LOOKS LIKE a field of broken dishes is really just a dried bed in one of the hottest spots in the United States—Needles, California.

The smashed pottery effect is produced after a flash flood when the scorching sun dries the mud rapidly and causes it to shrink and crack in thousands of places.

Ancient cracks much like these are of interest to geologists and paleontologists. It is not uncommon to discover layers of mud cracks sandwiched between other layers of sedimentary rock that are millions of years old. Mud layers are often abundantly rich in fossils and other interesting phenomena.

For instance, visible records of raindrops and hailstones that fell millions of years ago often show up as pockmarks slightly smaller than a dime. Animals, too, have left traces of their existence in the mud layers.

In addition to numerous fossils of whole organisms, many footprints have been found. Long-extinct species such as dinosaurs and early, primitive mammals have been studied in this way.

Mud cracks can occur nearly anyplace where the soil is composed of a mixture of clay and silt, often near a river bed.

In this issue

Page 26 *Amazing three-dimensional photographs from the new electron scanning microscope (B)*

32 *A first century Roman palace in England (C)*

34 *Why SST engineers have a tiger by the tail (A)*

43 *LSI: Three initials that spell electrical mini-everything for the future (D)*